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The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT : 1937-38

C. W. Bigg, "Selworthy," Burley Lane, Quarndon, near Derby.

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East Anglian : J. L. Francis, 12, Glenhurst Avenue, Colchester Road, Ipswich.

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BRITISH CAST IRON RESEARCH ASSOCIATION

The Registered Office and Laboratories of the B.C.I.R.A. are:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Colmore 4274-4275. Telegrams: CIRA
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

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The Pig-Iron Loyalty Rebate Scheme

We have had quite a number of inquiries relative to the practical operation of the scheme put forward by the Foundry Pig-Iron Producers' Association, most of which were cleared up by reference to the small-type italicised definition appearing beneath the title. This definition states that the foundry and forge pig-iron referred to in the document contains less than 0.75 per cent. of phosphorus. Thus, such irons as "cylinder," "cold-blast," "refined" and the like do not come within its ambit. One query which is not quite so easy of solution is where a contract has been placed for a delivery of pig-iron spread over the next year or so, to be paid for at the market price at the time of delivery. Though the contract was made before November 1, the basic date of the document, we imagine that throughout the duration of the contract the current price will read "so many shillings a ton less 5s. rebate," and such contracts can easily operate within the new agreement placed before the industry. The original conception of this scheme from the foundry owners' point of view was associated with the strengthening of their own employers' federations, but we see nothing in the new document which is at all helpful in this direction. We are still of opinion that advantage should have been taken of the opportunity to strengthen the hands of those foundries which, by co-operation, carry the burden of ensuring an economic price level for the products of the industry, either by agreement with the consuming industries, or by negotiating with public authorities, on such matters as railway rates, tariff adjustments and the like. The overwhelming difficulty in the creation of a body capable of speaking for the whole of the ironfounding industry has in the past been the lack of community of trading interests. Here, indeed, a splendid opportunity presented itself for the creation of an organisation of truly representative character, capable of meeting on equal terms the regimented industrial competition of certain foreign countries. Whether this opportunity has been finally missed, it is difficult to say. One thing, however, is certain, and that is that the regional system of organising foundry-employer activity does not give universal satisfaction, and where similarity of output has been the main feature, much greater—indeed outstanding—success has been registered. With an employers' federation such as we envisage, the organisation would be mainly in the direction of this latter type of activity. The main funds for such an association would be a beneficial differential rebate for members of an approved employers' association, with exceptions to take care of non-competing foundries such as those attached to the railway companies and engaged on the manufacture of non-competing specialties.

Lord Dudley's Appeal

We give elsewhere an account of the scheme made public for the first time by Lord Dudley at the recent B.C.I.R.A. meeting, and which has been under consideration by the Council for some months past. Briefly, this scheme aims at nothing less than the provision of up-to-date accommodation and equipment for the British Cast Iron Research Association at a cost of £30,000 to £40,000. The original laboratory was acquired in 1926 and has been gradually extended since that date. The Association is organised in such a way that the staff engaged on research as well as the staff engaged on development can draw on the services of specialised laboratories, such as chemical, microscopic, mechanical testing, sand testing, etc., as well as that of an experimental foundry. The object in view is to provide such equipment and apparatus as will enable the Association to carry out the work it is called upon to do with facilities at least as good as those available to the industry abroad. We understand that while the Council is alive to the value of adequate accommodation, particularly in its effect on the work of the staff, and conscious also that a suitable building will focus the pride of the industry and enhance its prestige, the major stress is laid on equipment and apparatus. The position is reflected in the most enlightened attitude among industrialists. They attach the greatest importance to their equipment and the staff who have to use it. While housing is a less important consideration, they would consider it unbusinesslike to house their machinery in unsuitable quarters.

It is clear that the scheme has the sympathy and will have the practical assistance of the Department of Scientific and Industrial Research, on whose behalf Viscount Falmouth spoke at the meeting. Excellent precedents in this matter have been created by other research associations, who have erected their own laboratories from funds which have been specially provided or saved for the purpose, and we believe in every case with satisfactory results. The associations relating to non-ferrous metals and to automobile engineering will come to mind in the group serving the metallurgical and engineering industries. The successful accomplishment of the scheme will mean a great deal to the industry and its progress will be watched with sympathetic interest. The annual luncheon was the best attended and most enthusiastic yet held, and Lord Dudley's speech undoubtedly created a profound impression.

The British Cast Iron Research Association

ANNUAL GENERAL MEETING AND LUNCHEON

The annual general meeting of the British Cast Iron Research Association, followed by the annual luncheon, was held in the Edward VII Rooms, Hotel Victoria, London, W.C.2, last Thursday, under the presidency of the Right Hon. The Earl of Dudley, M.C.

ANNUAL GENERAL MEETING

MR. J. G. PEARCE (Director and Secretary) read the notice convening the meeting. Apologies for absence were received from Lord Nuffield, Lord Wakefield, Lord Austin, Engineer-Vice-Admiral Sir Harold Brown, and a number of members. The minutes of the preceding annual general meeting, having been circulated, were taken as read, and were confirmed and signed.

Reports and Accounts

The PRESIDENT moving the adoption of the sixteenth annual report and the accounts for the year 1936-37, first expressed gratitude to the staff, and particularly to the director and secretary, for their splendid work during the year, as well as to the various committees which had controlled the Association's work.

The income for the year was between £16,000 and £17,000, and he understood that in that respect it had been one of the most satisfactory in the history of the Association. It was the Association's practice to spend practically the whole of its income, placing only a very small amount to reserve, and he understood that the current reserve was sufficient to carry on the work of the Association for only about three months. That was obviously the proper practice for such an association, because the members contributed their money in order that it should be spent to their advantage, and it was being so spent.

A very pressing and urgent need was that of securing better accommodation than was available so far for the Research Department, and, above all, better equipment. That matter he would deal with more fully at the luncheon

PROFESSOR EMERITUS T. TURNER, seconding the motion for the adoption of the report and accounts, said they showed that the Association was really alive and that good progress had been made during the year. The Association was doing well by its researches in assisting the development of an important national industry, particularly on the scientific side.

The annual report and accounts were adopted unanimously.

Re-election of President

DR. HAROLD HARTLEY (Chairman of Council), proposing the re-election of the Earl of Dudley as president for the ensuing year, said the Association had been very fortunate in the men who had served it as President in the past, but was never more fortunate than when it had secured the consent of the Earl of Dudley to occupy the post. It was a privilege and pleasure to propose his re-election.

MR. J. E. HURST (Chairman of the Research Committee) seconded, and the resolution was carried unanimously, amid applause.

The PRESIDENT, responding, said it had come as a great surprise to him to have been asked to accept the Presidency of the Association for a second year. He was rather overcome by the honour of his re-election, and he assured the members that he felt just as honoured and just as pleased to accept the office for the second year as he had been to accept it for the first year. He also assured them that he would do all in his power to further the aims and objects of the Association. The current year would be a most important one, for all concerned with the Association must do their utmost to raise money for the improvement of the accommodation and equipment. He could not accept the responsibility without the knowledge that he would have the full co-operation and help of all the members; they would not expect him to make such an appeal alone, and he would expect every member of the Association, and particularly every member of the council, to give him every possible assistance in raising the money which was so necessary for the continued success of the Association's work.

Re-election of Vice-Presidents

MR. S. H. RUSSELL proposed that Lord Austin of Longbridge and Prof. Emeritus T. Turner, M.Sc., A.R.S.M., F.I.C., be re-elected Vice-Presidents, in accordance with Article 23. Both gentlemen, he said, were so well known that it was not necessary to expound their virtues or to emphasise their qualifications for their offices. It was a very happy circumstance that one of the Vice-Presidents was one of the most prominent industrialists in the country, and the other might be described as the grandfather of practically all the research on cast iron in the country.

THE EARL OF DUDLEY
(President of the British Cast Iron Research Association).

The resolution was seconded by MR. W. JOLLEY and was carried unanimously.

Thanks to Retiring Vice-President

On the motion of MR. J. B. ALLAN, seconded by MR. P. A. ABERNETHY, and supported by the PRESIDENT, the warmest thanks of the Association and Council were accorded Mr. A. McKinstry, M.Sc., M.I.E.E., M.I.Mech.E. (who retired under Article 23), for his services as Vice-President.

Re-election of Council

On the motion of MR. T. W. BACHE, seconded by MR. H. WINTERTON, the following members of council, retiring automatically under Article 27, and eligible for re-election, or elected during the year, were re-elected:—Mr. P. A. Abernethy, Mr. C. W. Bigg, Major T. G. Bird, Mr. J. Cameron, J.P., Mr. E. W. Colbeck, Mr. E. C. Evans, Mr. H. Field, Mr. T. Firth, Mr. J. T. Goodwin, Mr. J. E. Hurst, Mr. W. Jolley, Mr. G. T. Lunt, Mr. T. Makemson, Mr. G. Pate, Mr. A. J. Richman, Mr. A. W. Steven, Mr. I. D. Taverner and Mr. P. H. Wilson.

Election of Auditors

On the motion of MR. D. H. WOOD, seconded by MR. V. C. FAULKNER, the meeting elected Messrs. Poppleton & Appleby, accountants and auditors, as auditors to the Association for the ensuing year.

Thanks to Council

MR. E. A. PHILLIPS proposed a hearty vote of thanks to the members of Council for their work on behalf of the Association during the past year.

The motion was seconded, and the vote of thanks accorded with acclamation.

Thanks to Staff

DR. HAROLD HARTLEY (Chairman of Council), proposing a vote of thanks to the staff for their work during the past year, said it was difficult to express adequately how much that work was appreciated, for he wanted the members of the staff to know that their work was deeply appreciated.

MR. H. B. WEEKS having seconded, the resolution was carried with enthusiasm.

Thanks to President

MR. J. B. ALLAN, M.A., proposed a hearty vote of thanks to the President for his conduct of the meeting, and said that all the members appreciated the fact that he had presided.

MR. W. B. LAKE, J.P., seconded.

The vote of thanks was heartily accorded, and the PRESIDENT assured the meeting that it had been a pleasure to attend.

THE LUNCHEON

The Earl of Dudley presided over a distinguished gathering during luncheon. The company included the Rt. Hon. Viscount Falmouth (Department of Scientific and Industrial Research), Mr. P. A. Abernethy, Mr. J. B. Allan, M.A., Mr. T. G. Bamford, Mr. C. W. Bigg (President, Institute of British Foundrymen), Prof. Sir Harold Carpenter, M.A., F.R.S. (Imperial College of Science and Technology, and Past-President of the Iron and Steel Institute), Engineer-Rear-Admiral A. G. Crousaz, Dr. S. F. Dorey, M.Inst.C.E. (Lloyd's Register of Shipping), Dr. A. P. M. Fleming (Metropolitan Vickers Electrical Company, Limited), Major F. A. Freeth, O.B.E., D.Sc., F.R.S. (Past-President), Engineer-Vice-Admiral Sir George Goodwin, K.C.B., LL.D., Lieut.-Col. J. H. M. Greenly, C.B.E., M.A. (Chairman, British Non-Ferrous Metals Research Association), Dr. Harold Hartley (Chairman of Council), Sir Patrick Hannon, M.P., Dr. W. H. Hatfield, F.R.S. (British Iron and Steel Federation), Mr. Joseph Hepworth, M.P., J.P. (Vice-President, Institute of British Foundrymen), Mr. Walter Higgs, M.P., Capt. R. S. Hilton, Sir Clement Hindley, K.C.I.E., M.Inst.C.E., Mr. R. G. Hosking, Capt. Barton Hudson (Master, Ironmongers' Company), Mr. J. E. Hurst (Past-President, Institute of British Foundrymen), Mr. G. H. Lightfoot (Commonwealth Council for Scientific and Industrial Research), Mr. F. J. R. Miles (Master, Worshipful Company of Founders), Sir Felix Pole, Engineer-Vice-Admiral G. Preece, C.B., Mr. S. H. Russell (Past-President, Institute of British Foundrymen), Mr. James Smith (President, National Ironfoundry Employers' Federation), Dr. T. Swinden, Prof. Emeritus Thomas Turner, M.Sc. (Vice-President), Mr. G. S. Whitham (War Office), and Mr. V. C. Faulkner (Past-President, Institute of British Foundrymen).

Following the loyal toast,

The PRESIDENT first paid a tribute to the late Lord Rutherford of Nelson, by whose recent death science had suffered a severe blow. As Chairman of the Advisory Council to the Department of Scientific and Industrial Research, Lord Rutherford had carried out an enormous amount of disinterested public work in addition to the physical research which had made him famous. In July, 1932, he had opened an extension of the Association's present laboratories and had

expressed the view that the Association should aim at an income of £40,000 per annum in order to discharge its responsibilities to the industry. At that time, said the President, the Association's income was about one-fourth of that sum, and he hoped that in the course of the next year or two it would reach at least one-half. Speaking for himself, and he believed also for the members of the Council, he did not consider Lord Rutherford's estimate to be excessive. It was obvious that if we in this country were to hold our own as the leaders of industrial development throughout the world we must spend more on research.

A year ago, he continued, he had said that no body of that kind could operate effectively and efficiently without proper equipment and accommodation, and he had expressed the hope that it would be possible during the good times to ensure the future prosperity of the industry—for which research expenditure was an insurance premium—by giving the Association suitable equipment and accommodation. The past year had not belied the promise of prosperity then held out, so far as industry was concerned; furthermore, the consciousness of the effect of a slump bred from our experience a few years ago was leading in various ways to movements which would tend to offset both the peak of a boom and its subsequent mirror image, the trough of a depression. He felt very strongly that the time had come when the Government and industry should sit down together and consider the problem in a really modern, up-to-date scientific way. He believed that a good deal could be done to level off the peaks and depressions and to give industrialists a real sense of security in the knowledge that the costs of their raw materials would not rise unduly over a period of years, which would enable them to quote economic prices for that period ahead. He hoped the present Government would take advantage of the opportunity, when the industrialists were in a suitable frame of mind, as now, to tackle the problem scientifically.

Laboratory Extension and Equipment

The Council of the Association, after some months' deliberation, had decided that the time had arrived to ask the industry to put the Association on a satisfactory footing so far as equipment was concerned. The Association did not possess any resources from which such provision could be made. Indeed, all the provision that could be made out of income had been made, and the reserves did not cover more than the cost of three months' working. The Council felt that at present it could look to the industry for the necessary assistance.

If he paused for a moment to consider what justification the Association had for meriting confidence, apart from the steady progress disclosed in successive reports, he would remind the gathering of the services of the staff set aside for dealing with technical and practical inquiries from members. The report showed that, including inquiries which were answered by the information bureau, they were dealt with at the rate of about five per working day. Those inquiries often involved analytical and testing work, sometimes minor investigations and not infrequently visits to members' works. That formed a direct return for the subscription income. The inquiries were welcomed, because it was through them that the staff learned of the problems confronting the industry in their day-to-day tasks. In addition, the research programme was continuously carried forward, the results of which were reported to members, and there was no doubt that the results had had in various directions a pronounced influence upon the development of the art and science of founding in this country. It was difficult to attach a direct financial value to such results, but there was one case in which such an estimate was practicable. It was suggested in the Report that the installations of the balanced-blast cupola, now approaching 180 in number, yielded, on a conservative estimate, fuel savings in this country of the order of £25,000 per annum—roughly three times as much as the industry furnished in each year by way of subscriptions to the Association. It was also suggested that something like 20 to 25 per cent. of the cast iron melted in Great Britain was being melted in that type of furnace, a result which after seven years' development was very striking. By means of meetings and reports, information was distributed to members, and he had no doubt that the mere machinery of bringing people together around the same table had advantages which could not be ignored.

Coming to what the Council felt should be done to ensure a contented permanent staff, the growing experience of which, of course, became increasingly valuable, the President said that the men who found their careers in that work did not ask for large material reward; the least that the Association could do for them was to provide reasonable accommodation, free from noise and external distraction, and with the equipment and apparatus essential to the conduct of their work. They did not ask for lavish or luxurious accommodation; but they could not be expected to do decent work unless they were decently housed. Subject to satisfactory work being done, they should also be able to look forward to reasonable progress and to have available a contributory superannuation scheme, which the Council hoped to provide at no distant date.

With respect to apparatus and equipment, it would be agreed that it should be not merely adequate in variety, but the best of its kind. That equipment was to be used for very important work, and unless it were available we should probably be missing something worth many thousands of pounds a year. Furthermore, we had to maintain the prestige of this country and, indeed, of the Empire in this field of work, and it was not right that countries with lesser responsibilities and smaller resources should be better provided. At its lowest computation it was not good business, and he appealed to all common-sense men to think that matter over.

Grant-Earning Gifts

The Council envisaged a scheme which would cost £30,000, although he would feel safer if he said £40,000. By arrangement with the Association's good friends of the Department of Scientific and Industrial Research, he believed that contributions for that purpose would be treated as grant-earning. The scheme under which the Association was working with the Department permitted more grant to be earned than was possible with the present income, and at the middle of 1939 a new five-year period would open. If members of the Association were prepared to furnish a sum roughly equivalent to double their normal annual subscription, preferably, but not necessarily, spread over a period of years, the aim in view would be accomplished, for it should yield £15,000. The Council regarded the question of equipment and apparatus as the first consideration and that of accommodation as secondary. It must not be thought that accommodation was not important; it was only just secondary to equipment. What they desired was to ensure that members had available through the Association all that was required adequately to carry out their responsibilities to the industry. The staff kept an eye on what was being done abroad, and were naturally jealous of the standing and prestige of the industry so far as this country was concerned. Therefore, he was glad to make the first official announcement of the scheme, which he warmly commended to the attention and the generosity of the industry.

To those firms who had yet to be persuaded to support the Association, he said that the work of the Association was of undoubted benefit to the industry as a whole, and hence to all firms in it. He hoped all non-member firms would soon conclude that they could scarcely fail to benefit from such an annual expenditure; and in that he was fortified by the recent remarks of the Prime Minister at Manchester, in referring to the growth and importance of the research association movement and to the necessity for increasing our expenditure in that direction. One of the greatest difficulties had always been to enlist the active interest and support of the user of those products in so far as he was not the maker. The general public, of course, could scarcely be expected to respond; but he had in mind principally those engineering and other works not having foundries, and who bought their supplies from founders. Hence, he felt fully justified in extending the invitation to support the scheme to *all* who were concerned with the industry.

In such a widespread and relatively unorganised industry, concluded the President, the Association must rely on its good friends, the Press, to make known the points on which he had concentrated; he thanked them for their assistance in the past and for their continued co-operation. He wished the Association every possible success in the coming year, and said he would do his best to raise the money for the new equipment and premises which the staff needed so badly. But in that work he must have the co-operation and sympathy of every member of the Association.

The RIGHT HON. VISCOUNT FALMOUTH (Department of Scientific and Industrial Research), who was invited to speak, commented on the vitality and life of the founding industry, and said that although a few years ago there were some age-long industries which were content to proceed as their grandfathers had done, practically all industry nowadays appreciated the vital importance of industrial research. The Government was fully alive to the importance of industrial research, as was evidenced by the activities of the Department of Scientific and Industrial Research. Until recently the Advisory Council of that Department had been presided over by Lord Rutherford, one of the greatest experimental physicists who had ever lived, and whose name would go down to coming generations as that of one of the outstanding men of all time. He had been the heart and soul of the Industrial Research Council, and all who had known him were appalled by his sudden death.

Referring to the support which the Government was giving to industrial research through the Department, Lord Falmouth said that about £600,000 of the taxpayers' money was spent in research each year. Quite a considerable part of that was spent by research associations, and a considerable sum was devoted to the maintenance of the National Physical Laboratory. There were research associations serving all the great industries of the country, and, of course, the cast iron industry was one of the most important. Of the income of £16,000 odd of the B.C.I.R.A., some £5,000 or £6,000 was given by the Department of Scientific and Industrial Research by way of grant. But that was not all that the Association could be entitled to under the present arrangement; if it increased its income from the industry it could obtain another £2,000 a year from the Department. He hoped sincerely that the Association would do its best to secure further subscriptions during the next two years, so that it could earn that extra £2,000 a year.

The co-operative research that was being carried out in England, he continued, was unique among the countries of the world. Much research was carried out in the United States, often in magnificently equipped establishments. In England, we had not the great aggregations of capital which enabled them to establish such great individual research laboratories; but through co-operative research, by means of which the smaller units could get together and pool

their resources, we were able to provide facilities equally good as, if not better than, the Americans had in their great laboratories. Lord Falmouth endorsed the appeal made by the President for funds with which to provide further accommodation and equipment; he assured the members of the Association that the Department wished to help them as much as it could, and that it wanted them also to help themselves, and said he was sure that the Association, with the co-operation of the Department, would go forward to even greater achievements than those of the past.

MR. WALTER HIGGS, M.P., proposing a vote of thanks to the President for his address, said that the Earl of Dudley was well known throughout the country for his very great interest in research, and his interest was very highly appreciated. It was impossible for the average-sized business to carry out research on all the products it used. His own business, for example, used a large number of semi-finished products—steel, cast iron, copper, insulation, varnishes, and a huge number of components. A business might be able to carry out research on its main product, but such a business as his could not do research on cast iron. That argument applied to a large number of people and, therefore, they combined, their united efforts producing results beneficial not only to the subscribers, but ultimately to their whole industry, through which the results percolated, and to the nation.

The fact that we manufactured here a large number of commodities under licence proved that countries abroad, where research organisations existed to a greater extent than in this country, were ahead of us in original production. Again, the fact that many British factories were using machinery made abroad proved that the countries in which those machines were made were leading in those particular productions. It was only by industrial research that we could compete with foreign nations and equip our factories with all-British equipment. Discussing the Association's need for further funds and for Government assistance, he said that everybody wanted Government assistance. He believed that assistance was wanted more from within the industry. The output of cast iron in this country was in the neighbourhood of 600,000 or 700,000 tons per month, equivalent to 7,000,000 or 8,000,000 tons per annum. Assuming its average value was £10 per ton—a ridiculous figure—it represented an enormous turnover, of about £70,000,000 a year. The Cast Iron Research Association, however, had spent £16,400 during the past year, equivalent to a little over 4s. per £1,000 turnover.

MR. CHARLES W. BIGG (President, Institute of British Foundrymen), seconding the vote of thanks to the President, said that presumably the Association, when inviting the Earl of Dudley to become its President, had acted on the principle that when we wanted something done we appealed to the busiest man we knew. They all admired the enthusiasm and energy with which he approached all his tasks. To all who were concerned with the development of one of our oldest industries, concluded Mr. Bigg, the address given by the Earl of Dudley to the members and friends of the B.C.I.R.A. must be of the greatest possible encouragement.

DR. HAROLD HARTLEY (Chairman of Council), who supported the vote of thanks, took the opportunity also to refer to the Association's activities. The activities of the British Broadcasting Corporation, he said, had made everybody familiar with the methods adopted by those who, on Sunday evenings, appealed on behalf of charitable organisations. The B.C.I.R.A., however, in appealing for the £30,000 or £40,000 required to provide new accommodation and equipment, could not go to the general public; it was not a charitable organisation in the ordinary sense, but was founded, with the support of the Department of Scientific and Industrial Research, as a centre of research and development for the cast iron founders. As the President had said, it was good business to become a subscriber to the Association. Dr. Hartley emphasised also that one of the functions of the Association was to ensure that there should be planned development throughout the industry. It was of no use relying on brilliant discoveries by brilliant individuals, for brilliant individuals were few and far between, and the number of such discoveries was of the second order of magnitude. Most discoveries were made as the result of hard work along intelligently thought-out lines. The Association had officials who spent their whole time thinking of cast iron, the improvement of its qualities and the extension of its applications; they studied metallurgical processes with the single thought in mind as to whether developments in those processes became applicable to cast iron. He contended that that was very valuable. Reference had been made by the President to certain tangible results of their work; but, in addition, the work was having a moral effect. It was raising the standard of work throughout the whole industry.

The vote of thanks was carried with enthusiasm and the gathering toasted the President.

THE PRESIDENT, expressing his thanks for the manner in which the toast had been proposed and the very generous and hospitable manner in which it was received, said he felt he could really count on the support of all the members in the appeal for funds. He was determined that by the end of his year of office, with the help of the members, the Association would have gained the money it sought for its very important work; at any rate, if the money were not raised he would be extremely disappointed.

Pickling Iron Castings with Hydrofluoric and Sulphuric Acids

The process of pickling iron castings with hydrofluoric and sulphuric acids, which was the subject of an inquiry in the JOURNAL for October 21, is carried out in a lead-lined tank, having a match-board lining to protect the soft lead. Two other tanks are required, one to contain clean running water and the second an iron tank heated by steam and filled with a dilute solution of soda.

To start, No. 1 tank is filled to within a few inches of the desired working height with water, and hydrofluoric and sulphuric acids are added at the rate of half a gallon of each to every ten gallons of water. The acids should be measured out in a lead-lined bucket, and the operators should wear rubber gauntlet gloves to protect their hands. No. 2 tank is filled with water, and No. 3 tank is a 10 per cent. solution of washing soda, warmed nearly to boiling point.

The castings are lowered, by means of mild steel hooks, into No. 1 tank, and allowed to remain therein about 4 hours. The castings should next be removed and swilled in water in No. 2 tank, and then transferred to No. 3 tank containing hot soda solution, where they should be left for sufficient time to get really warm, so that the acid is thoroughly neutralised, and sufficient heat is absorbed to dry the castings quickly. They are finally swilled again in water in No. 2 tank.

The strength of the acid bath is maintained by the addition, whenever necessary, of equal quantities of each acid, in quantities which are determined by titration. When the strength is satisfactory, the evolution of gas from the castings should resemble the rise of gas from soda recently drawn from a syphon.

A fair amount of mud and insoluble dirt accumulates in the pickling tank and the soda tank, and this should be removed as often as necessary with a scoop. A dirty scum forms on the top of the soda solution while it is being used. This needs to be skimmed off frequently.

N. L. E.

Activities in East Anglia

A visit to the Nacton Works of Crane, Limited, Ipswich, was the first event in the winter session of the East Anglian Section of the Institute of British Foundrymen. Members of the London Branch also participated in the visit, which took place on October 21.

The plant is particularly interesting, due to its extensive application of mechanisation to the production of pipe fittings, valves, radiators and central-heating apparatus. Much of the machinery has been designed by the firm to fulfil its special requirements. The visit afforded an opportunity of seeing balanced-blast cupolas in action, as one is installed in the grey-iron foundry and another in the malleable foundry.

The visitors also inspected the new laboratory building which is in the course of completion, and which is designed to cater for the routine requirements of the malleable, grey-iron and non-ferrous foundries, and also for research work and special investigations. The building is of a single storey and self-contained, being well separated from the main works and surrounded by grass verges. Even in its unfinished state it gave every indication of eventually being definitely superior to the usual laboratory installed for foundry control.

After the inspection of the plant tea was provided, and on behalf of the visitors MR. L. J. TIBBENHAM thanked Mr. G. C. Detlefsen, Mr. H. H. Shepherd and the guides. The vote of thanks was seconded by COL. C. PORTWAY.

Following the works visit an ordinary meeting was held in the lecture hall at the Central Library, Ipswich. MR. L. J. TIBBENHAM gave his presidential address, which was followed by the reading of MR. A. H. SQUIRE'S Paper on "Some Problems Involving the Accuracy of Machine-Moulded Castings,"* and also by a Paper on "Metal Patternmaking and Machine Moulding," read by MR. H. M. ABBOTT.

Presidential Address

In the course of his address MR. L. J. TIBBENHAM said that there had recently been an exhibition in London, and the foundry equipment industry was very badly represented. He did not know whether the industry was too busy, or whether it was not interested. However, he was sorry to see the bad representation. There had not been any great advance in the foundry industry during the past 10 years. There were, of course, new core-blowing machines and cupolas, but in very few cases were there any drastic improvements. He said he liked to see progress. Another thing which had affected the foundry industry was the greatly increased cost of raw materials and increased rates of pay.

He suggested that in the future very large castings would be replaced by welding, likewise small castings. Even to-day, he said, some of the small castings have been replaced by other materials, such as bakelite.

Coronation Competition Awards Announced

It is announced that the prizes in the Coronation Competition, organised by the Lancashire Branch of the Institute of British Foundrymen, have been awarded as follow:—

First Prize.—Mr. T. R. Harris, of Cambourne, Cornwall, for a Paper entitled "The Production of Some Intricately-Cored Castings, Illustrating Some Aspects of Modern Ferrous Foundry Practice."

Second Prize.—Mr. A. R. Parkes, of Stowmarket, Suffolk, for a Paper entitled "Metallurgical Control in a Repetition Foundry producing Grey Cast Iron."

No entries were received for the Non-Ferrous Section of the Competition.

* FOUNDRY TRADE JOURNAL, April 15, 1937, p. 319.

Impact Testing from a Physical Standpoint*

By R. V. SOUTHWELL, F.R.S.

As the author and his colleagues see the matter at Oxford, whatever be the purpose for which impact-testing was developed (that is, whether as an acceptance test having its own intrinsic value, or merely as a convenient check on heat-treatment), every accepted test can be said to have this feature, that a standardised specimen is subjected to a standardised type of impulsive loading (what one might call a "standardised bad time") in a standardised machine, and the measured quantity—in this Paper it will be termed the "work done to fracture"—is taken as an indication of merit. (The author does not say "figure of merit," since it has been emphasised by many authorities that the measured quantity is to be interpreted not absolutely, but qualitatively, and only in relation to the known composition, etc.)

Now manifestly this procedure, and therefore any test to which it is applied, is justified from the standpoint of a steelmaker who desires to ensure a satisfactory product; any experiment which can help him, and is easy to carry out, has earned its place in the scheme of mechanical tests. But can an experiment be considered satisfactory by the scientific metallurgist, as to which there is no agreement regarding the property which is measured, or basis for the reduction of results? From the older static tests—tensile, torsional or compressive—although their interpretation seems less simple now than it did to their originators, one does at least obtain results expressed in units which are physically comprehensible—elongation as a percentage of the original gauge-length, ultimate stress in tons per square inch, and so on; but what is to be said of a test in which both the need and the difficulty of standardisation come mainly from this fact, that there is no real understanding of its dimensional factors?

What is, ultimately, the purpose of an impact test? Admitting its value as a control test, what property of the material does one really seek to measure? Is it such as could be measured (though perhaps less conveniently) in other ways, or is one concerned with some quality not revealed by static tests, and, if so, is that quality desirable? No apology is made for these questions as unpractical, even to those who are concerned only to produce better steels; for until one has defined the purpose for which a test is intended, how can one argue with those who press for its deletion, or discuss the merits of any particular technique?

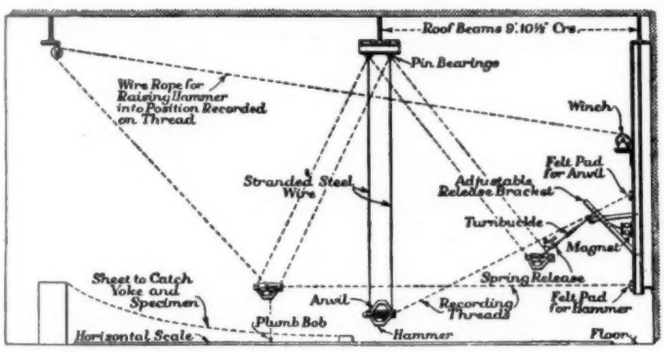


FIG. 1.—GENERAL ARRANGEMENT OF "OXFORD" MACHINE.

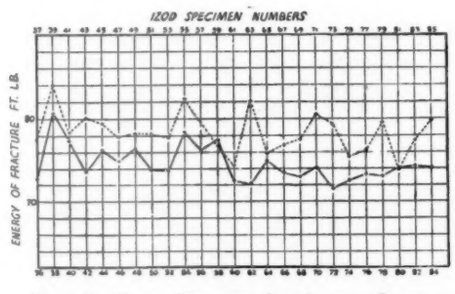
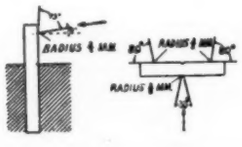


FIG. 2.—IZOD (BROKEN LINE) AND OXFORD (SOLID LINE) ENERGIES COMPARED.

The Oxford "Ballistic" Machine

This desire to get down to fundamentals underlay even the first experiments, which were planned not to test a particular material, but to check what seemed to be an unproved assumption made in existing tests—that the measured "work done to fracture" does in fact represent energy absorbed by the specimen. Since the quantities actually measured are the initial and final energies of a certain mechanical system, any leakage of energy which may escape observation will on this basis be wrongly credited to the material; the author suspected that a leakage to earth must occur in machines of the rigid-pendulum type and he set himself to measure its amount. Thus he was led to the "ballistic pendulum" design, an idea suggested in 1921, but which did not materialise until Mr. Lavery set up the first machine in 1930.



FIGS. 3A AND 3B.

Details of the machine are more easily understood from a diagram than from a lengthy description; Fig. 1 shows (substantially) the arrangement now adopted. Using a machine of this type, Mr. Lavery was able to fracture similar specimens by the same kind of loading both in an Izod machine specially "tuned" to give accurate readings, and "ballistically." Results confirmed the expectation that the "Oxford" figures would be lower. The most conclusive evidence was obtained from 50 specimens of an identical material (Vickers' "Vibrac V.30"); it is given in Fig. 2, whence it appears that between 4 and 5 per cent. of the Izod figure represents energy transmitted to "earth" as a shock wave.

The Oxford Specimen and Method of Loading

Almost as soon as the new machine was in operation, equally strong objection was taken to current methods of applying the impulsive force. In the Izod test, where the specimen is held as a cantilever (Fig. 3A), the resultant action at the notched cross-section has a shearing component superposed upon the bending-moment; and in the Charpy test, where the specimen is notched at its central section and broken by a striker impinging on it at a point immediately behind the notch (Fig. 3B), the stresses which are brought into existence can only be conjectured. There was no hope of explaining fractures caused by such complicated stress-systems, and it was therefore decided to break the specimens under "four-point loading," using a "yoke" to transmit the force of impact, as shown in Fig. 4. Here the usual milled rectangular specimen is replaced by a much cheaper specimen which can be machined at one setting in a lathe; and although the stress-distribution is complicated by the necessity of a notch to start the fracture, it can at least be said that this occurs under stresses which (by symmetry) are purely normal.

The author has employed this type of specimen in all work done since 1930. It has greatly cheapened the cost of the experiments, while the ballistic machine has enabled him to impose checks on his observations (*e.g.*, by keeping a "momentum account") which would not be possible in a conventional machine. Systematic experiments made by Lavery in the latter part of 1932 showed that the results are insensitive to small variations (*e.g.*, sharpness of notch) which can occur due to errors of workmanship; on the other hand, later experiments by H. Hallam (1934) proved conclusively that the power to detect "notch-brittleness" had not thereby been lost, and recent work by E. Warlow-Davies (1936) has demonstrated the general proportionality of Izod and "Oxford" figures over a wide range (Figs. 5 and 6).

Results Obtained: The "Area Law"

The author now has two "ballistic" machines in operation, with the result that from each large specimen he can obtain, in effect, three tests on the same piece of material. This is for the reason that broken half-specimens, in the "Oxford" test, show hardly any sign of plastic distortion; practically all of the "work done to fracture" has been absorbed by material in the region immediately adjoining the fracture. The crack runs straight across the plane of the notch and for either size of specimen the energy absorption is closely (though not exactly) proportional to the area of fracture: that is why, in Figs. 5 and 6, the "Oxford" figures are expressed in foot-pounds per sq. in.

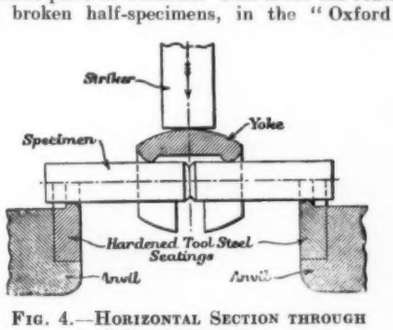


FIG. 4.—HORIZONTAL SECTION THROUGH C.I. OF SPECIMEN.

In objection to the claim that practically all of the energy absorption occurs in a region immediately adjoining the fracture, it has been

* From a Paper contributed to a discussion organised by the Manchester Association of Engineers on October 29.

urged that on this view the proportionality of Izod and "Oxford" results, Figs. 5 and 6, is not intelligible, because, undoubtedly, in the Izod test, much of the energy goes to produce general distortion of the specimen. This difficulty, the author thinks, is more apparent than real, and will disappear if (as seems reasonable) one assumes that in a standardised specimen the total energy of fracture is partitioned in a constant ratio, for then the total energies of fracture will be proportional, even though the ratio has very different values in the two tests.

As the author visualises the test, a notched specimen is necessary because (unless the material

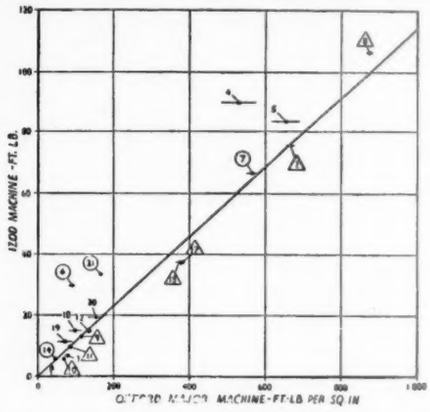


Fig. 5.—Comparison of Results of Izod Impact Tests with those from "Oxford" Major Machine.

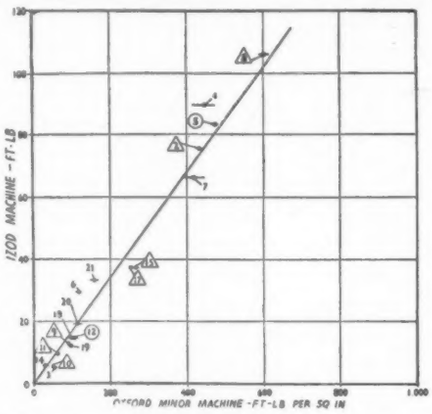


Fig. 6.—Comparison of Results of Izod Impact Tests with those from "Oxford" Minor Machine.

is very brittle) an unnotched specimen would absorb the energy of the striker without fracturing—it would dissipate it in plastic distortion. But if a crack is compelled to start, then a tough material absorbs more energy, because by resisting the spread of the crack it brings into existence stresses which are outside its own elastic limit; a notch-brittle material, on the other hand, opposes so little resistance to the spread of a crack that this can run through the specimen without overstraining more distant parts and, in consequence, little energy is absorbed. In conventional tests, much of the work done to fracture a tough material is expended in producing plastic distortion of parts remote from the fracture: qualitatively it gives an indication of the local stress required to propagate a crack, but only if one adopts a standardised specimen, of which the plastic distortion will be definite for a definite value of that stress. If one could eliminate plastic distortion in regions remote from the crack, the exact shape of the specimen would no longer be important; that is what is done in the "Oxford" test, and that (the author believes) is why his results are insensitive to small variations of form.

Suggested Explanation of the "Area Law"

Of the happenings in an "Oxford" specimen, the author states that two things are known—that fracture occurs in the plane of the notch, and that the stress which acts across this plane must (by symmetry) be purely normal; hence, it would seem, fracture occurs when—and only when the cohesion of the material is overcome, *i.e.*, the molecular forces of attraction between opposite sides of the plane. The start of the fracture, no doubt, is conditioned by such factors as the depth and sharpness of the turned notch, but the width of the section is negligible at the start, and thereafter it is the sharpness of the natural crack which determines the stress-concentration, not factors which can vary on account of errors of workmanship.

One may be certain that the natural crack is very sharp, so the stress-intensification at the root must be enormous, and except as regards its cross-section, the shape of the specimen can have little effect. Again, though plastic slipping no doubt occurs in the crystals immediately adjoining the root, a simple argument shows that it must be extremely localised. Thus one attains, finally, to a picture in which all important occurrences are confined to a thin layer containing the surface of fracture, and one may expect to find (as, very approximately, one does) that the "work done to fracture" is expressed by an "area law."

Experiments Using Static Loads

This theorising (possible only because of the manner in which the specimen is loaded) can to some extent be checked, because it is easy to load specimens similarly in a static test (Fig. 7) and to measure the "work done to fracture" under slow-loading conditions. Work on these lines was done by Lavery as early as 1930, and throughout the author's investigations static experiments have kept step with the impact tests. It is very significant that they reproduce all the essential features of the latter; thus Hallam showed (1934) that they serve almost as well for the detection of "notch brittleness," and that the results are expressed by a very similar "law." Recently Warlow-Davies (in work for a thesis not yet published) has greatly improved their accuracy, and in diagrams relating the resultant action and distortion he has usually interpreted, which is something distinct from ductility and of importance in parts which are liable to shock, because it controls the spread of a natural crack. Warlow-Davies' experiments suggest that it is operative even when the crack is formed under static loading, so that shock is not the essence of the problem; but an impact test seems the most convenient means to its investigation, and in this sense may be said to give additional information. The author cannot see, as yet, any other ground on which the impact test can be justified from a physical standpoint; but his view, if correct, implies that practical conditions should be reproduced as closely as possible, *i.e.*, that the spread of the crack should be conditioned by principal stresses. In theoretical objection to the Izod and Charpy tests the author has stated that their stress-distributions are incalculable; as a practical objection he contends that they correspond with nothing likely to occur in service.

What are the circumstances governing the spread of a natural crack? It is a question which many investigators have studied in relation to fatigue, but there it is complicated by a multitude of factors, and no satisfactory answer appears to be forthcoming. One would expect the problem to be more simple when the crack is formed continuously, whether the process be fast or slow, but (as it appears) because current methods of loading have entailed distortion of the specimen as a whole, relatively few attempts have been made to explain crack-formation under these conditions.

The most pressing problem in this study of natural cracks may be termed the problem of scale-effect. It lies at the bottom of all questions of dimensions and their standardisation. Why do dimensions matter? Why are non-concordant results obtained from specimens of differing size? A striking example of scale-effect is shown in the two curves given in Fig. 8. They may not have caused surprise, for it is a commonplace that large specimens are more "brittle" than small. Why?

A scale-effect in specimens broken by impact does not necessarily conflict with theory, because the velocity of stress-propagation is the same both in large pieces and in small. But in regard to two specimens geometrically similar and tested statically, theory would argue thus:—Similar distortions will satisfy all the conditions of equilibrium, whether elastic or plastic: they

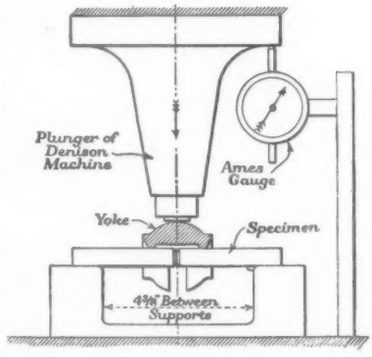


Fig. 7.—Apparatus for Static Tests.

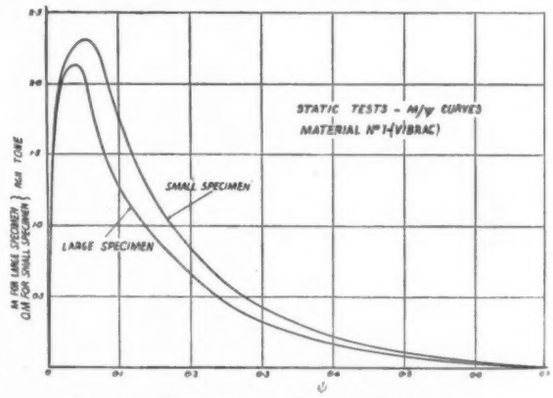


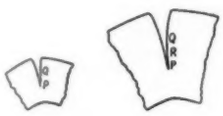
Fig. 8.—Discrepancy between Results on Large and Small Specimens.

laid foundations on which, some day, the author hopes that a tolerably fundamental theory will be erected. Extremely satisfactory "repeats" were obtained: Fig. 8 is a typical diagram.

The author believes the purpose of an impact test is to measure the resistance of a material to the spread of a natural crack, *i.e.*, its power to resist fracture as contrasted with plastic distortion. This, right or wrong, is the assumption on which work is proceeding at Oxford. He believes that there is a quality of materials, not revealed by static tensile tests as these are entail the same strain at corresponding points, therefore (in a given material) the same stresses; so the two specimens should behave similarly under similar load-systems. The stresses occur on areas which are proportional to the squares of the linear dimensions, so the forces required for equilibrium will vary as L^2, and the bending moments and energy of fracture will vary as L^3, L denoting the scale-ratio. In Fig. 8, since the bending moments for the smaller specimen have been multiplied by 8 (L = 2), according to this argument the two curves should be identical.

In seeking to account for this discrepancy one may not have recourse to a mysterious "speed" or "skin effect," so-called "explanations" which merely alter the statement of the difficulty. The discrepancy is a feature of static experiments and the fracture can hardly be governed by properties of the material lying close to the machined surface. Nor can one reject the experimental evidence, for the discrepancy is quite outside the margin of possible error. Therefore, it appears, something must be wrong with the theory, and all that can well be wrong is its assumption that the specimens are geometrically similar.

When two specimens are made of the same material, the larger has relatively the finer microstructure, and as such may be expected to behave as though more brittle. The sign of this explanation is correct and it is based on common experience; but it, too, restates



Figs.—9A and 9B.

rather than removes the difficulty, since brittleness is merely the quality of low resistance to fracture, and it is not known why it should be characteristic of fine-grained materials. Geometrical similarity does not extend to the limiting range of action of cohesive forces, for it is these ultimately (after plastic slipping has had its effect in re-adjusting stresses) that alone can resist the spread of a crack.

Assume two specimens geometrically similar and similarly deformed by an action of the kind which is imposed in the "Oxford" test (Figs. 9), and instead of the assumption usually made in regard to cracks, suppose that forces of cohesion operate in those parts of the crack where the width is less than the radius of molecular attraction. In the smaller specimen (Fig. 9A) one may suppose them to be operative in the part PQ at the root of the crack.

Now, according to the argument from dimensional theory for similar distortion of the larger specimen, it is necessary that corresponding forces should be operative in the part P′Q′ of its (geometrically similar) crack. But cohesive forces will not operate in the region of Q′ because there the crack is too wide: they will be restricted to a smaller region P′R′, and to this extent the resisting moment will be reduced. Arguing in this way, one obtains a qualitative explanation of the curves in Fig. 8.

What seems wanted now is a theory which will make this explanation quantitative and the author is trying to develop one. It must be "macroscopic" and in some degree it must be illogical, since in a theory which contemplates materials of the nature of a structureless jelly there can be, strictly, no place for molecular forces. But although illogical, it may still be useful, and these, for the present, are the lines along which the author will make his search.

(*Concluded from next column.*)

were presented, one by Mr. C. H. Kain, of the London Branch, entitled "Can the Metallurgist Run a Foundry?" and the other by Mr. A. Tipper, B.Sc., of Birmingham, entitled "Synthetic Sand *versus* Natural Sand."

Mr. Kain's Paper provoked very useful discussion, but unfortunately the discussion of the second Paper had to be postponed to a later date owing to lack of time. Two talkie films describing the Austin motor-cars and works were shown by courtesy of the Austin Company.

Altogether the conference was an undoubted success.

German Foundrymen's Technical Association

The German Foundrymen's Technical Association is to hold a special meeting dealing with non-ferrous foundry practice in the Great Hall of the V.D.I. building, 37, Hermann Goering Strasse, Berlin, on November 26 and 27. The programme, in addition to including a number of works visits, has arranged for the following Papers to be presented:—

"Casting Technique and Anodising of Aluminium and Aluminium Alloys," by Ing. H. Röhrig (Lautawerk).

"Melting and Casting of Lead-Calcium Alloys," by Count von Göler (Frankfort-on-Main).

"Casting of Remelted Aluminium, Pure and Alloyed," by Prof. Dr. Ing. W. Guertler (Berlin).

"Magnesium Castings," by Dipl.-Ing. H. Luyken (Berlin).

"New Knowledge on the Influence of Melting and Casting Conditions on the Gas Content and Structure of Aluminium Alloys," by Dipl.-Ing. G. Gürtler (Frankfort-on-Main).

"Progress of Electric Heating in the Heavy and Light Alloy Non-ferrous Foundry," by Dr. Ing. Fr. Knoops (Freiburg).

"Oil Furnaces in the Non-ferrous Foundry."

"Establishment of a Unified Price List in the Non-ferrous Foundry Industry," by F. Höhne (Leipzig).

Further detailed information can be had by applying to the Geschäftsstelle des Vereins deutscher Giessereifachleute, 100, Friederichstrasse, Berlin, N.W.7.

Birmingham-London Joint Meeting

The Birmingham Branch of the Institute of British Foundrymen acted as hosts to the London Branch on October 22 and 23. Last year a successful meeting was held in London, and this was the first occasion on which the Birmingham Branch had entertained members of another Branch. A party of about 20 London members were met at Coventry on the Friday morning, and were conveyed by cars to the works of Sterling Metals, Limited, Northey Road, there joining the Birmingham party. After making a tour of the works, during which members had an opportunity of observing the manufacture of castings in Elektron metal, the whole party proceeded by cars to the works of Midland Electric Manufacturing Company, Reddings Lane, Tyseley, Birmingham, partaking of luncheon *en route* at the Phœnix Hotel, Coventry. About 50 members visited Sterling Metals, Limited, but the number rose to 90 for the afternoon visit.

At the Midland Electric Manufacturing Company's works the members saw the recently installed mechanised plant, which constitutes one of the most up-to-date mechanised foundries in the country, and were afterwards entertained to tea by the management.

In the evening the London members were entertained at an informal supper at the Golden Eagle Hotel, and thanks to the assistance of Mr. Percy Owens (comedian) and the orchestra, everyone spent a most enjoyable evening.

On Saturday, October 23, about 75 members visited the Austin Motor Works at Longbridge, and made a tour of the machine and press shops and the steel and iron foundries. Luncheon was taken at the works, followed by the business meeting, which was held by courtesy of the management in the Austin showrooms. Two Papers

(*Concluded at foot of previous column.*)

Action of Alkalis on Refractories

Discussing the action of alkalis on refractories in Report No. 385 of the Materials Sub-Committee of the Verein deutscher Eisenhüttenleute, published in "Stahl und Eisen," F. Hartmann suggests that the increasing use of alkali-containing slags in metallurgical practice makes a comprehensive experimental survey of the action of alkalis on refractory materials desirable. In investigating this aspect of the subject of refractories' properties, the author distinguishes between attack from alkaline vapours, molten alkalis and alkaline-containing slags.

Experimental work by the author showed that alkaline vapours caused a fairly rapid transformation of the fine matrix of silica bricks already at moderate temperatures, this matrix being in fact dissolved out from the surface. The resistance to this action increased with the size of the quartzite grains, but in all cases the silica bricks retained their shape and strength. On the other hand, firebrick, when attacked by alkali vapour, became depth-softened already at 1,000 deg. and were readily deformed. In contact with molten alkalis, a vitreous film of slag was produced on the surface of firebrick, which commenced to swell to a marked degree. Magnesite bricks were found comparatively stable under both forms of attack, but chrome-ore/magnesite bricks very easily disintegrated when exposed to either molten alkalis or alkaline vapours, the action penetrating right into the interior as the chrome ore was decomposed chemically. In spite of their high alumina content, bauxite bricks became distorted on exposure to the vapours of alkalis, the mass fusing to form an alkali-aluminium silicate melt and the volume of the brick increasing rapidly.

Plastic Refractories

The rammed lining of a hot-metal ladle composed of plastic refractory clay was completely destroyed by molten soda with the formation of a large number of fine cracks. Attack could be considerably reduced by using suitable refractory clays with low clay contents. Examination of the attack of alkaline-containing slags on magnesite bricks for pig-iron mixers indicated that these bricks were increasingly attacked as the alkali content of the slag increased, the bricks swelling considerably. This observation applied to slags with high contents of silica and lime. On the other hand, slags with a high Mn and Fe content became more viscous as the alkali concentration rose, and were hence less liable to attack refractories. This result was confirmed by measuring the viscosity of such slags in relation to the temperature, on the basis of the assumption that a slag had a more active attack the lower its viscosity at a given temperature. The viscosity of highly-basic slags, similar to blast-furnace slags, could not be reduced by the addition of soda.

In the discussion to this Report it was stated that of various alkaline salts sodium sulphate readily attacked refractories. In the desulphurisation of pig-iron with soda the slag had less action on the refractories than the vapours rising from the melt, and which combined with the silica in the bricks, causing swelling and cracks. The problem as to which refractories were most resistant to alkali attack had not yet been disposed of. In ladles used for desulphurisation with soda a rammed lining had, however, proved more stable than a brick lining. According to M. Pasclhke and E. Peetz, firebrick with a moderate alumina content (approximately 38 per cent.) and of exceptional high density (approximately 8 per cent. pores) exhibited the greatest resistance towards fused alkalis and alkali-rich slags. The resistance to alkali could also be increased by the addition of graphite (5 to 10 per cent.), according to reports of the Solvay Company.

Question Night in Falkirk

PRACTICAL PROBLEMS SOLVED

The recent "Question Night" arranged by the Falkirk Section of the Institute of British Foundrymen, provided members with the opportunity of discussing a variety of interesting practical problems. Mr. H. Cowan, B.Sc., chairman of the section, presided over the meeting.

The first question discussed was:—

"What are the causes of metal becoming dull towards the end of a run of about 12 tons in a 42-in. dia. cupola?"

MR. JAMES WRIGHT suggested that it was due to too much air and too little coke. MR. JOHN DONALDSON agreed that this was the crux of the matter. The experience of MR. WILLIAM MCARTHUR was that it was due to the dropping of the bed; he had found in practice that if the bed was increased the trouble disappeared. MR. HENRY MCNAIR advised increasing the charge of coke slightly as the correct thing to do, and MR. ROBERT URE suggested that the cupola operator might have wrongly estimated the amount of metal, and it was important to use a first-class, strong coke for the bed.

"Why does there seem to be less cohesion in enamel on small castings than on large ones?"

MR. DONALDSON'S opinion was that a thick casting did not have as good cohesion as a thin casting, due to the fact that the castings were over-fired. MR. G. C. WILSON pointed out that knobs and handles on doors often suffered from this lack of cohesion when enamelled. MR. MCNAIR described as unreliable the testing with a hammer for the extent of cohesion. It might be due to inefficient sand or shot blasting of the knobs or handles; this was as important as the relative thicknesses of the castings. MR. DONALDSON added that the difficulty was sometimes due to design. He did not think a perfect casting ever came into the enamelling shop, from the designer's point of view. The CHAIRMAN agreed with this comment, and said the trouble was due particularly to differences in section.

"Can any method be arrived at to control the moisture content of moulding sand?"

MR. MCNAIR presumed that facing sands were meant, and said it was simple to test with a moisture meter, which was not expensive. In the opinion of MR. R. KIDD, the problem was difficult, and each case could be settled only by finding a solution for the various problems as they arose. MR. URE referred to a machine which controlled the moisture content of sand, but which was not economical in use, and the CHAIRMAN agreed that it would pay only in a mechanised foundry where large quantities of the same type of article were produced.

"It has been claimed that wet coke is at least as efficient as the same quality in the dry state for cupola work. Is this so, and if so, why?"

MR. MCARTHUR'S objection was that in a wagon of 10 tons of wet coke they were also paying partly for the water. The CHAIRMAN, agreeing, created laughter by saying that Falkirk water was not as dear as 35s. and 40s. a ton. MR. DONALDSON said there was definitely a difference, and one would get a higher temperature with the same weight of wet coke than of dry. When the coke was passing down the cupola, the moisture evolved as steam hindered combustion. The coke reached the bottom before combustion began, and one then got the heat where it was wanted. MR. URE observed that, in blast-furnace practice, the opposite was the case. Even in a cupola good dry coke was doing its work all the time, and if it was driving off moisture it was not melting pig-iron. With wet coke one lost from a half to one cwt. of the charge. MR. DONALDSON pointed out that the cases were not parallel, and MR. WILSON said it made very little difference, as what was gained by the coke reaching the tuyeres unburnt was lost in driving the water off as steam. The CHAIRMAN said that when charging was finished, the charge began to drop, and when it was three feet below the charging door it was red hot. His view was that it did not matter in the slightest. It was a Falkirk foundryman who had the ingenious idea of wetting the coke and thus preventing the fuel burning right away. A development was the German idea, adopted in a number of English foundries, but so far in none in Scotland, of coating the coke with lime; with the cost of liming, the extra efficiency might not be worth while. MR. JOHN SMITH said he had been in close association with the foundryman referred to by the Chairman. He had holes put in his furnace every foot, and he absolutely proved to his own satisfaction that the wet-coke theory was correct, and that he was getting the heat lower down.

"What is considered the best mixture of facing sand for light castings?"

MR. MCARTHUR gave one mixture as six barrows of black sand, two of Erith medium, one of Belfast red and six pails of coal-dust (five pails to a barrow). The CHAIRMAN said that represented 13 or 14 per cent. of coal-dust by volume, and MR. KIDD said he had a similar mixture, but with only five pails of coal-dust. MR. SMITH'S opinion was that the moulder had to use his own discretion, either to reduce or increase the strength of the facing sand by coal-dust.

"What is the best facing sand to use for enamelled castings?"

MR. MCARTHUR said he produced rather rough castings which, although they were not liked in the dressing shop, were first-class castings for enamelling. He had found black sand was best. MR. DONALDSON agreed it was better to aim at a rough surface; there was no point in putting a galvanised surface on a casting when it was going to be blasted off. MR. MCARTHUR added that there was no coal-dust, but occasionally a scattering of yellow sand was put over the black to renew its strength. MR. KIDD stated that he used Erith and the red sands and very little coal-dust. MR. WILSON agreed there was more danger when using black sand alone, due to silt. The CHAIRMAN concluded the discussion of this topic by saying that, so long as one made a sound casting, so long would it be possible to make a good enamelled casting. The blue skin on a casting was a fetish that had been thrown to the winds, and coal-dust he thought in the future would be in a foundry museum.

"Is large-size coke necessary for bedding purposes in the cupola, even in a large diameter cupola?"

MR. WILSON did not think it necessary, the main factor being the strength of the coke. MR. DONALDSON felt the draw-out was much easier if the coke size was larger, while MR. SMITH said the finest coke he ever used was Westphalian, none of it bigger than his hand. MR. URE pointed out there were three or four cwts. more of the smaller coke in a bed, and MR. MCNAIR preferred a large-size coke to allow easier passage of air.

"What can be done, either in the moulding shop or the enamelling shop, to prevent bubbling or boiling in lugs and bosses on light castings?"

This could largely be overcome, MR. DONALDSON said, by more attention to annealing, double or treble running if necessary. MR. MCARTHUR'S opinion was that it was a moulder's problem, and the casting should be run as far away from the heavy section as possible. MR. KIDD said it was not for the moulder, but for the pattern-shop; an endeavour should be made to eliminate the lugs in the design.

"Are two rows of tuyeres on different levels inferior to one?"

MR. DONALDSON suggested two would be better than one if they were properly designed, but the CHAIRMAN said that, provided the scrap was not heavy, one row was equally efficient, and more economical.

"Has silicon any effect on the melting point of cast iron, or is it governed solely by the carbon content?"

MR. MCNAIR said that all impurities in iron lowered its melting point, so that silicon must reduce it. The CHAIRMAN pointed out that white iron with very low silicon had the lowest melting point of the whole range. The more silicon, the less carbon there was, and the higher the silicon, the higher was the melting point.

"What causes worm marks on light castings?"

MR. KIDD'S view was that they were largely the result of too high moisture, MR. WILSON agreeing. MR. MCARTHUR'S experience was that invariably he experienced this marking with pure yellow sand. MR. MCNAIR spoke of some experiments he had made with synthetic sand bonded with Bentonite, and said the worm mark was actually a shearing of the sand face due to expansion of the sand. In his opinion, the sand buckled and caused an indent in the metal. In his experiments the synthetic sand actually sheared so badly that there was a sharp line of cleavage in the sand. That sand had a permeability which no ordinary moulding sand ever had, the moisture was low and it possessed reasonable working strength. The worm marks were not on the runners, but on the face of the casting. The CHAIRMAN pointed out that some worm marks were caused by the joins where the metal met, but MR. MCNAIR said that in this case a semi-misrun casting was definitely out of the question. Sea sand had been used, and on the Chairman's suggestion, MR. MCNAIR agreed to bring the sample to the next meeting.

Notes from the Branches

Lincoln Section.—The November meeting attracted the largest gathering of members so far registered. Mr. Dunleavy presided, and Mr. V. C. Faulkner was the lecturer, his subject being "Foundry Machinery." MR. FAULKNER took about a dozen departments of the iron-foundry industry and detailed what he considered to be the proper type of equipment for mechanised, large jobbing, medium-sized and small foundries. In conclusion he gave a review of the outstanding exhibits at the Düsseldorf and Milwaukee foundry exhibitions. An interesting discussion followed, and the lecturer was accorded a vote of thanks, proposed by MR. G. L. HARBACH and seconded by MR. E. C. CARROTT. Replying to this, MR. FAULKNER expressed his sincere thanks for the reception accorded to his lecture and to him personally from the moment of his arrival in Lincoln, especially by Mr. Walter, the Principal of the Technical College.

Welsh Manganese Mines

It is stated that there is every prospect of the Egryn manganese mines, situated between Barmouth and Dyffryn, in Merionethshire, being re-opened after being idle for more than 15 years. The mines are the property of the Barmouth Urban Council, and gave employment to miners before and during the war.

Copper in Cast Iron and Malleable Iron

By W. B. SALLITT

(*Concluded from page* 357.)

II.—COPPER IN MALLEABLE IRON

Copper has proved itself a valuable addition to blackheart malleable iron, since it both accelerates annealing and also improves mechanical properties.

Effect on Annealing

Copper additions to blackheart malleable have a marked effect on the rate of formation of temper carbon, which increases progressively with

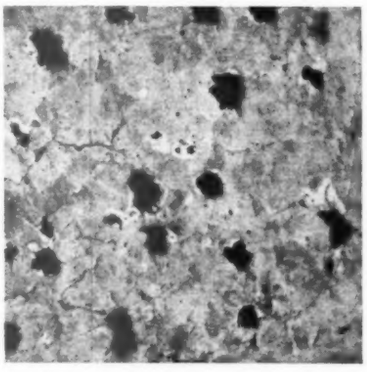


FIG. 13.—WHITE CAST IRON CONTAINING 1.2 PER CENT. SI AND 1 PER CENT. CU, ANNEALED 2 HRS. AT 925 DEG. C., AIR COOLED. ETCHED SODIUM PICRATE. × 200. NOTE FINE NODULES OF TEMPER CARBON. (SMITH & PALMER.)

the copper content up to the limit of solubility of copper at the soaking temperature, *i.e.*, about 3.5 per cent. The explanation appears to lie in the fact that copper in solution favours the formation of a larger number of carbon nuclei in the initial stages of breakdown. Figs. 13 and 14 show the structure of a copper-free and 1 per cent. copper iron respectively, after two hours'

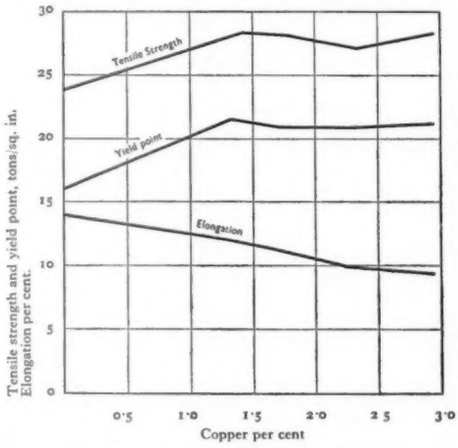


FIG. 15.—EFFECT OF COPPER ADDITIONS ON MECHANICAL PROPERTIES OF BLACKHEART MALLEABLE IRON CONTAINING C 2.4, SI 1.01, MN 0.31, P 0.144 AND S 0.075 PER CENT. (LORIG & SMITH.)

soak at 925 deg. C., etched in boiling sodium picrate, which stains cementite brown (photographs black). It will be noticed that, although the breakdown has been more complete in the copper iron, the carbon nodules are appreciably smaller. This refinement of temper carbon is reflected in the improved mechanical properties of copper-bearing malleable iron discussed later.

Table IV shows the time required under laboratory conditions for the two stages of graphitisation—the breakdown of free carbide and of pearlitic carbide respectively—in an iron containing 2.4 per cent. carbon, 1.01 per cent. silicon, 0.31 per cent. manganese, 0.144 per cent. phosphorus and 0.075 per cent. sulphur. Experiments with higher carbon irons and varying soaking temperatures have given similar results. The shortness of these annealing times may come as some-

TABLE IV.—*Influence of Copper on Graphitising Malleable Iron.*

Copper, per cent.	Time, at 925 deg. C. for first-stage graphitisation. Hrs.	Time, at 725 deg. C. for second-stage graphitisation. Hrs.
—	8.0	13.2
1.33	5.2	6.0
1.73	4.0	5.5
2.94	2.4	4.5

thing of a shock to those accustomed to cycles of several days in the batch type, and even tunnel furnaces, but low-carbon copper malleable is today being fully annealed in atmosphere-controlled continuous annealing furnaces in as little as 13 hrs.

Mechanical Properties of Copper Malleable Iron

Fig. 15 shows the effect of increasing copper additions on a malleable iron which was annealed in a commercial furnace to give an all ferrite matrix. An addition of 1.4 per cent. copper produces an increase in tensile strength of 3½ tons per sq. in., and in yield point of 5½ tons per

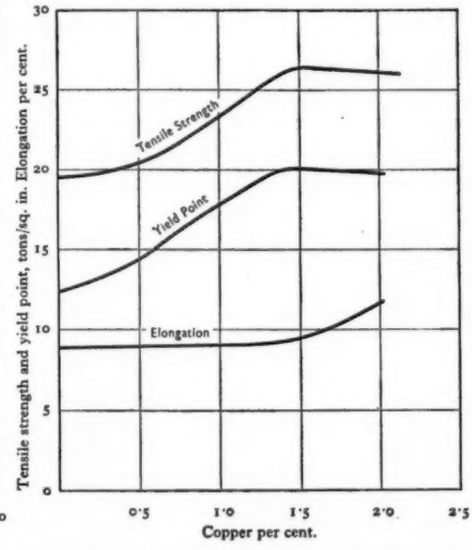


FIG. 16.—EFFECT OF COPPER ADDITIONS ON MECHANICAL PROPERTIES OF BLACKHEART MALLEABLE IRON CONTAINING C 2.8, SI 0.95, MN 0.27 AND P 0.12 PER CENT. (LORIG & SMITH.)

sq. in., whilst the elongation is reduced from 14 to 12 per cent.

It will be observed that the base iron is a low-carbon malleable of fairly high strength. It may be seen from Fig. 16, however, that if copper additions are made to weaker high-carbon irons, the tensile strength and yield point can be raised to almost the same figures, *i.e.*, about 27 tons per sq. in. and 20 tons per sq. in. respectively. Since the weakness of high-carbon irons is mainly due to the fact that the temper-carbon nodules are relatively large, the equality of strength in high- and low-carbon irons containing copper is an indication of the refinement in temper carbon arising from the copper addition.

Malleable iron is susceptible to intergranular embrittlement when held at temperatures of about 500 deg. C., as, for example, in the galvanising process. It is therefore often necessary to precede galvanising with a corrective treatment which consists of quenching from about 650 deg. C. The presence of copper, however,

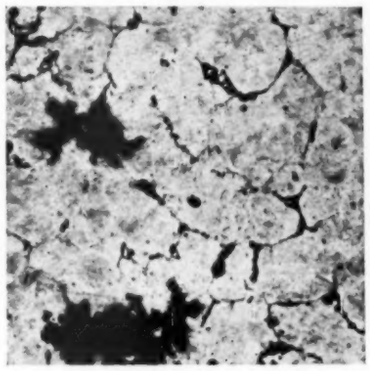


FIG. 14.—WHITE CAST IRON CONTAINING 1.2 PER CENT. SI AND NO COPPER, SAME TREATMENT AS IN FIG. 13. ETCHED SODIUM PICRATE. × 200. (SMITH & PALMER.)

greatly reduces this tendency to embrittlement and obviates the necessity for such preliminary treatment. As shown in Fig. 17, copper-free irons are very brittle after galvanising as compared with annealed irons, unless they have previously received a corrective treatment; but in irons containing upwards of 1 per cent. copper, the impact resistance after galvanising is about the same as in annealed copper-free irons. The curves in Fig. 17 incidentally show the general improvement in toughness arising from copper additions.

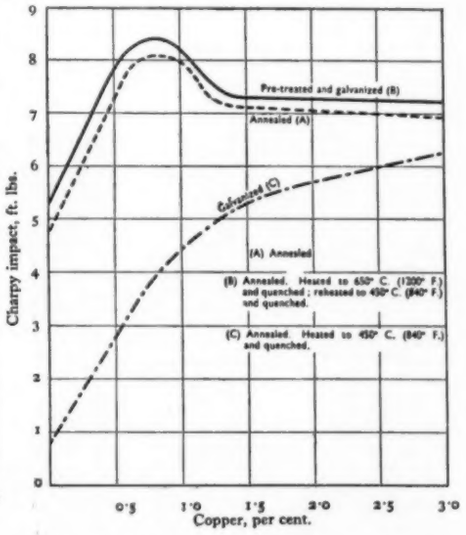

Pre-treated and galvanized (B)
Annealed (A)
Galvanized (C)
(A) Annealed.
(B) Annealed. Heated to 650° C. (1200° F.) and quenched; reheated to 430° C. (840° F.) and quenched.
(C) Annealed. Heated to 450° C. (840° F.) and quenched.
Charpy impact, ft. lbs.
Copper, per cent.

FIG. 17.—EFFECT OF COPPER ON IMPACT RESISTANCE OF MALLEABLE IRON. (LORIG & SMITH.)

Whiteheart Malleable Iron

There does not appear to be any record of copper additions to whiteheart malleable iron. However, in view of their beneficial influence on blackheart malleable iron, the Copper Development Association is now investigating the effect of copper on the mechanical and annealing properties of whiteheart. The investigation has not, as yet, proceeded very far, but in Figs. 18 and 19 are shown the microstructure at the core of two whiteheart bars poured from the same ladle

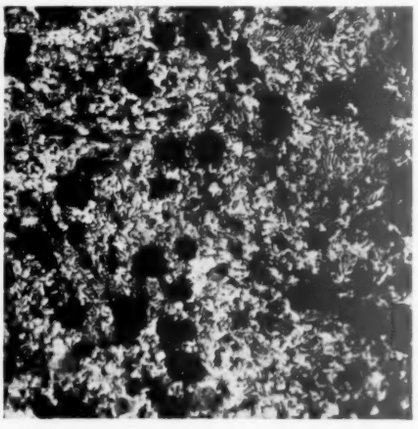


Fig. 18.—Microstructure of Whiteheart Malleable Iron (Core) containing 1.65 per cent. Copper. Etched Picric Acid. × 100. (B.C.I.R.A.)

and containing 1.65 per cent. copper and no copper respectively. Both bars were given a quick anneal in the same pot, the whiteheart process being employed. The analysis of the two bars after annealing was as follows:—

	No. 1. Per cent.	No. 2. Per cent.
T.C	2.46	2.58
C.C	0.75	0.93
Gr.	1.71	1.65
Si	0.78	0.79
Mn	0.40	0.39
S	0.231	0.240
P	0.052	0.051
Cu	1.65	—

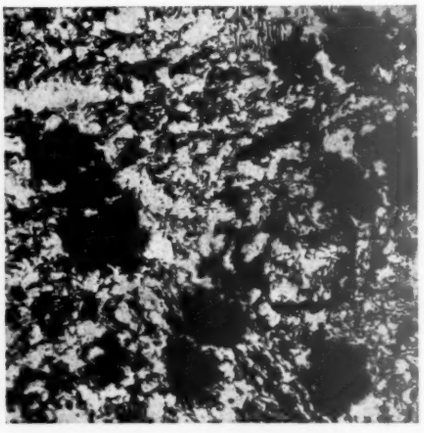


Fig. 19.—Microstructure of Copper-free Whiteheart Malleable Iron (Core). Etched Picric Acid. × 100. (B.C.I.R.A.)

The refinement of temper carbon in the copper-bearing iron is very marked, and cannot fail to have a favourable influence on mechanical properties, although this has yet to be confirmed by means of tensile tests. Moreover, a comparison between the combined and total carbon contents of the two bars as annealed, indicates that the addition of copper has not only promoted the breakdown of combined carbon to temper carbon, but has also accelerated the diffusion and reduction of iron carbide—the essence of the whiteheart process.

The author wishes to express his gratitude to the British Cast Iron Research Association for permission to use information contained in Research Reports Nos. 124 and 125, to the Ealing Park Foundry, Limited, for permission to include data on copper additions to Meehanite cast iron, and to Sir W. G. Armstrong Whitworth & Company (Ironfounders), Limited, for their co-operation in connection with the step-bar castings illustrated in Figs. 2 to 4.

DISCUSSION

Mr. F. K. Neath said it had, of course, been obvious for some years that copper was a useful element to add to cast iron as well as to steel; it was, moreover, considerably cheaper in use than some of the more familiar alloys. Mr. Sallitt had made considerable reference to the use of copper in the Ford motor works. That concern had done much research, and it was certain that the question of cost had entered into the matter as well as other factors. Members would appreciate from Mr. Sallitt's lecture, however, that cost was by no means the only point to be submitted in favour of copper additions. Mr. Neath said he was sure members would look forward to the opportunity of reading Mr. Sallitt's book on the subject when published.

Additions of copper were very easy to make, and did produce a more uniform and wear-resistant structure. Mr. Sallitt had dealt with the subject chiefly in relation to motor-car parts; in the West Riding, foundrymen were concerned largely with textile plant and machine tools, and they would be glad to learn whether the lecturer had had any experience of copper additions to castings for such purposes, and if so what his conclusions were in regard to improved wear resistance and closening of grain.

Mr. Sallitt replied that the use of copper had been so far chiefly confined to industries making light castings such as the motor industries, and he had not had experience of copper being used for really heavy castings. It was, however, apparent that the refinement and hardening of the matrix by copper were little affected by cooling rate, in view of the fact that copper produced a considerable increase in hardness and strength in fully-annealed steel castings.

Mr. S. Carter, referring to the claims for copper addition in the direction of Brinell hardness, inquired whether it might perhaps create difficulties in machinability. He also asked whether the lecturer would explain the reason for the inverse action of copper on the hardness of thin or thick sections.

Mr. Sallitt said, in reply to the first question, that copper was present in cast iron either in solution or as fine particles of what was virtually pure copper. In neither form could it lead to any machining trouble, despite the increase in Brinell hardness. As to the second question, copper by its graphitising action removed chill from, and never softened, thin sections, but by its alloying and refining action strengthened and hardened thicker sections.

Impurities Added with Copper

Mr. H. A. MacColl, B.Sc. (Bradford Technical College), inquired which of the alloy irons mentioned required heat-treatment. Was there any beneficial thermal effect or improvement in heat-conductivity, and were these copper irons being used in the manufacture of rolls? Mr. MacColl noted also that Mr. Sallitt had mentioned the use of old fire-box scrap, which might contain substantial quantities of arsenic. What would Mr. Sallitt consider the limit of impurities permissible?

Mr. Sallitt replied that only the low-carbon white irons such as were used for crankshafts were heat-treated; copper did not increase the heat-conductivity of cast iron. As regards rolls, experimental work was proceeding in that direction, and in answer to the fourth question he had not found any harmful effect resulting from such impurities as might be present in copper fire-box scrap, etc.

Mr. A. S. Worcester asked whether, in a copper alloy, there might be a danger of the copper "sweating" out in beads on the face of the metal. Mr. Worcester noted also that the lecturer had referred only to low-carbon irons, and he wondered whether there was any reason against copper addition to ordinary high-carbon irons of, say, 3 per cent.?

Mr. Sallitt said that all copper was in solution above the critical temperature, so that there was no danger of sweating. In regard to carbon content, most of the experimental data, used to illustrate the lecture, referred to irons with a fairly low-carbon content. Low-carbon irons were, of course, considerably stronger than higher carbon irons, and many people took the view that the first step in securing a high-duty iron was to lower the carbon content. However, copper had proved itself to be effective in high-carbon irons; for example, the carbon in the two camshafts ran as high as 3.65 per cent. and in the push rods 3.90 per cent.

Influence of Phosphorus

In answer to a member who asked whether phosphorus content had any substantial effect in the addition of copper, Mr. Sallitt said he did not think the phosphorus content mattered at all in so far as the graphitising action of copper was concerned, but naturally the beneficial effect of copper on strength would be obscured if the phosphorus content were very high.

Mr. Neath said he was inclined to think this might be a point worthy of further inquiry. When alloy additions to cast iron were first introduced into this country, foundrymen started putting all manner of things into the metal, and they experienced shrinkage cavities, porosity, open grain, etc. He felt there was scope for every member individually to make some research on this ground. In Mr. Sallitt's own work, he would like the lecturer to visualise the average jobbing foundry in which there was usually only one mixture. If he could give any lead, or any member could assist with his own experience, it would lead to valuable information.

Mr. Worcester asked if Mr. Sallitt could say that, in an ordinary 3 to 3½ per cent. carbon iron with, say, 1 per cent. phosphorus, copper would have a beneficial effect.

Mr. Sallitt said that by preventing open grain, it would be beneficial.

How Sulphur Reacts

In answer to Mr. Carter, the lecturer said there was no danger of copper combining with the sulphur in cast iron, since the affinity of manganese for sulphur was higher than that of copper.

Vote of Thanks

Mr. Neath, moving a vote of thanks to Mr. Sallitt, suggested it would be worth while for all members to do a few experiments with copper additions. Personally, he intended carrying out a series. He felt satisfied that, treated properly, copper was a useful addition, and certainly had an advantage in the matter of cost.

Mr. Slingsby, seconding, said Mr. Sallitt had given a most illuminating outline of the value of the process. He had, however, shown that the addition of copper tended to break down the carbon, whereas they had always been given to understand that the carbide should be retained in a malleable casting. Perhaps the lecturer might offer a little more enlightenment on that point?

Mr. Sallitt, replying to the vote of thanks, and to Mr. Slingsby's comment, reminded the meeting that copper was a more powerful graphitiser during the annealing than in the casting, which was one reason for its usefulness as an addition to blackheart malleable iron.

Can the Metallurgist Run a Foundry?*

By C. H. KAIN

PART I

Nuttall's Standard Dictionary defines the metallurgist as "one who works in metals." Now all good practical foundrymen know that a metallurgist is not a worker in metals at all, but a sort of chemist, full of book learning, without the ability to judge the quality of sand by rubbing it on a spade handle, and quite unable to "make a good casting to save his life."

The engineer grants the metallurgist more respect, but rather suspects him of being an alchemist and a person to be avoided. The company director usually looks upon the metallurgist as a new-fangled fad who ought to be able to produce the new alloys so much in the news from whatever old metal happens to be in the stock yard.

The question to be considered is whether this person of many aspects is capable of running a foundry?

The dictionary says the foundry is a place where metals are cast, but for what reason is a foundry conducted? Surely the primary object is to make a living, money or profits. How then is this aim achieved? Ultimately by making castings for less money than can be obtained for them in the market place. In one case it may be that the foundry aims at producing special high-quality products which command a very high price, either because of their rarity or because of their special properties or virtues. In another case the foundry may aim at producing goods which sell on price alone. In all cases, the fundamental requirement is the same, namely, to produce for less money than the selling price. The problem is therefore primarily one of economics.

PART II

In considering the matter from this angle two queries arise:—(1) What are the problems arising in the foundry which may prevent the products being made for less than the price obtainable in the market? (2) What special abilities or attributes does the metallurgist possess to deal with these problems?

If one considers the second question first, it is found that the metallurgist is usually a person with a good general and technical education and usually a sound metallurgical training in some college, university, school or laboratory. Sometimes he has had practical experience, either on the floor, at the bench or in the laboratory. In his metallurgical lectures and reading he has learnt how such famous predecessors as Bessemer, Huntsman, Dudley, Thomas and Gilchrist were primarily inspired to their discoveries by economic considerations.

If he has been at all properly reared and his early education decently supervised, he will be free from the parochial bias which considers, on the one hand, all new and fresh ideas as being bad and something to fight against, and, on the other hand, all old (and proven) or traditional practices to be old fashioned, out of date and something to be rejected. He may lack that contact with the soil (or floor) which is so helpful in handling men, but he ought to have the wit and knowledge to bide his time. On the face of it, such a person appears to be admirably equipped to run a foundry.

Before considering the problems which may interfere with the successful running of a foundry, it is desired to stress the importance of output. The foundry, like every other manufactory, lives by output, whether that output be great or small. It is therefore of primary importance that the output should be maintained in the face of all problems and difficulties and at almost any cost.

It is here that the metallurgist may fail. In conversation with metallurgists it has been noticed that there is a tendency to sit back, scratch the head and say of a problem . . . . "a very interesting question. Let us consider it," and to consider the problem academically *as* a problem and not as something which interferes with output.

The problems or factors which may interfere with the successful and profitable running of a foundry fall under three heads, namely, economic, technical and psychological.

The economic questions cover such things as adjustment of output to meet increasing or decreasing demands, planning or laying out of the work to be done and the apportionment of wages and piece-work rates. One of the most difficult duties is to estimate. It is necessary to estimate the possible production of the shop and the factors affecting this; also to supervise the actual estimate of the cost of a casting or for an inquiry. Time-study methods, together with accurate recording, will help a great deal in this, but experience (or genius) is frequently a most important factor. The Costing Sub-Committee of the Institute of British Foundrymen has done a great deal of work in this field, but in applying even their excellent methods to a pure estimate, imagination, invention and experience are necessary.

To get the most out of the foundry, it is necessary to visualise possible methods of production giving the maximum output of castings with the minimum expenditure of labour and materials. Probably the surest way to attain the ability to do this is from long experience; but exceptional men seem to have an instinct for rapidly devising suitable methods. The question then is: "Will the metallurgist benefit from his opportunity for gaining experience quicker than other men?" or "Can he acquire that instinct which unhesitatingly suggests the right methods?"

It would not be out of place here to state that the rewards of engineering generally are less than any other profession, and the foundry is the worst situated part of engineering. This applies to owners as well as employees. The foundry owner or director may have what is known as "a decent job," but the reward is very small compared with the work, worry, risk, labour and turnover involved in his business. Similar remarks apply to the employee, great or small. It may be asked whether the rewards of the foundry trade are sufficient to attract the best ability.

Technical Problems

In the original preparation of this short Paper, it was intended to give a number of illustrations of the numerous technical problems which call for solution during the running of a foundry. Further consideration, however, suggested that most of the author's audience would be only too familiar with them, and that it would be redundant to detail a list here. It might be stated, however, that technical problems largely fall into three classes, namely, mechanical, founding and metallurgical. The first covers such items as dimensional inaccuracy, cross-joints, the mechanics of the various moulding operations and arrangements whereby adequate feeding of a casting may be ensured without presenting the fettling department with an impossible task in the removal of the headers. The second deals with moulding, gating, feeding, choice of boxes and the use of stays in the mould or denseners on the casting. The last class is almost infinite in its variety, and ranges from the hard casting in the iron foundry to porous castings in the steel shop. It covers silicon losses in the cupola as well as the provision of satisfactory test-bars in the non-ferrous foundry.

Here again it is necessary to stress the point that output must be maintained. All these problems must be settled and decided without serious interruption of output.

The question is whether the metallurgist can either solve these varied technical problems himself or supervise someone who can. It is hoped that, with the intimate knowledge many have of this subject, this question will be decided in the discussion.

Psychological Factors

Finally, it is necessary to say something of the psychological factors entering into the successful running of a foundry. It is important to realise that development and progress can best come from men and not from machines. Ultimately, it is upon the correct choice of personnel that success depends. The owner must select his metallurgist or other person to run his foundry, and the one selected must choose his helpers and assistants. Here it is well to remember that, "when life is young, it ever struggles forwards."

In selecting personnel it is wise to remember the statement by Mr. J. P. Morgan, the banker, in 1913, that "there is no substitute for character." The first material to examine then is *men*, not machinery. It is here that science may lead experience astray, since science is primarily concerned with machines and processes, rather than with character.

Modern production methods tend to destroy character and not to create or develop it. These methods have not been devised in the interests of moral development; they are primarily designed for the adequate satisfaction of material needs or for the effective transaction of the national business. It is a truism to say that industry recks little of individual life; rather does it advance over the sacrifices of the workers who serve it. There is nothing derogatory in service; rather is "Service a Blessing and a Great Liberty" (Mme. de Stäel). It must be remembered, however, that even the welfare schemes are devised not for the benefit of the individual, but rather that he may become a more efficient worker for industry.

It has been suggested that the training schools and colleges do not turn out the right type of men. It is said that they are rather like

"Vicars' daughters who look so good,
We think that they are made of wood;
Like rests for hymn books there they stand,
Each with a hymn book in her hand."

This standardisation is something to be avoided, because mass similarity can easily become mass stupidity. Adam Smith said that "Industrial specialisation is simply mental mutilation" ("Wealth of Nations"). The trade unions could render a great service here if they would forsake the profitless pursuit of politics, for which they are ill-equipped, and concentrate upon the supervision of the training of craftsmen. They could do no greater good than to foster a revival of the excellent apprentice system of the guilds of the much despised Middle Ages.

To aim at making things, rather than merely turning them out in prodigious quantities; to aim at quality rather than quantity, and quantity can easily be achieved after the quality is established, are fundamental principles. Burke said that "example is the school of mankind, and they will learn at no other." What a glorious opportunity presents itself to our unions and labour leaders to-day to set the example!

In selecting men with the best character, it is suggested that imaginative powers be given prominence. A vividly imagined aim is the antidote

(*Concluded on page* 382.)

* Paper read at a joint meeting of the Birmingham and London Branches of the Institute of British Foundrymen in Birmingham.

The Scope of Sales Films

By ERIC N. SIMONS

It is of little use to stress the sales and educational value of an industrial film to the foundry unless one attempts, at the same time, to indicate the scope of such films. The founder contemplating the employment of this type of publicity naturally asks himself: "What can a film show of my work?" The functions of the industrial film have been discussed in a previous article. The founder may, however, have been quite convinced that a film would benefit his business, without being convinced that he has anything to make a film of, and without knowing what he will have to pay.

Films can be of two main kinds, directly to sell the castings, or educational. To amplify this statement, it may be said that the sales film proper is an attempt to show the virtues of the goods, and may cover the following themes:—(1) The place of manufacture, its advantages and convenience; (2) the methods of manufacture, their soundness and systematisation; (3) the uses of the castings, either shown theoretically or exhibited in actual practice at some user's establishment; (4) the testing of the castings, to ensure soundness before despatch; (5) the raw materials of the castings, their sources, their testing, the care devoted to them; (6) the men who make the castings, their skill and experience; (7) the delivery of the castings, its organisation and efficiency. Other variants can be supplied from the founder's imagination or from practice.

The educational film, on the other hand, is an attempt to sell the castings by ensuring that they are properly treated, and therefore give good results in use; or by exhibiting the technical or other advantages that accrue from their employment.

It will be advantageous to take characteristic synopses of a film of each of the two types, in order to show the main outlines on which the founder should concentrate if he contemplates purchasing a film for his own use.

The Sales Film

To begin with, a little history is usually a good opening. Show the earliest types of machines, and the simplicity of castings that were used then. Show the foundry as it was a hundred, fifty, ten, or five years ago, if the comparison has any point or is feasible. A close-up of a photographed group of old-time workers, complete with beards and moustaches, is always amusing. Show the foundry to-day, and, in quick flashes, the incoming mail with its orders, the drawing offices, the pattern shops, the manufacturing processes, in detail or condensed, according to the structure of the film. Close-ups of any specially valuable process, or of any process in which extreme skill or care are displayed. A few spectacular flashes of pouring metal. Then a return to the raw materials, maybe an iron mine, or a cargo boat chugging across the sea. Unloading ore or pig at the docks, or a goods train speeding to the works are good features. Workers all over the world, perhaps, in their characteristic occupations, preparing the raw materials; miners, engineers, etc.; testing laboratories and appliances; a close-up of a few lines of a specification, are typical essentials. Then back again to the finished casting, showing its despatch, its reception, its introduction into a machine, the machine functioning efficiently, diagrams of stresses borne, and so to the conclusion, which should introduce the foundry again, its name and reputation.

Educational Films

Here the subject matter is naturally more varied, and it is less easy to find a generally characteristic theme. But, as most castings function better if properly treated, one may assume that the "education" to be administered concerns this treatment. The foundry is shown. A letter of complaint is received. Or, since this is open to objections, this section might be eliminated and the foundry expert shown arriving at a customer's works. He presents his card, and a boy takes him to the works manager. He is shown a casting which has not proved satisfactory, perhaps. He examines the methods of use. He takes off his coat, and demonstrates (with adequate close-ups, use of slow motion, and the like devices), the proper way of handling them. The dialogue here must be especially clear and explanatory, with plenty of questions and answers. The questions must, however, be natural and not silly ones, questions such as a purchaser might actually ask during a demonstration of this kind. A little humour is permissible, but this must be carefully introduced. Humour is dangerous, and quite innocent jokes have been found to give offence. The user clears up his final points. The demonstrator shakes hands and is shown departing for his next visit.

Personnel Difficulties

These bald synopses are intended only to indicate possible themes of films of the two types enumerated. Variations are legion, and the imaginative founder will see for himself how his wares can be most effectively dealt with, especially with a good consultant to prompt him, Certain points in connection with all films need, however, to be borne in mind. The dialogue *must* be natural, and if this cannot be written by a member of the foundry staff himself, it will be better to employ a trained film scenario writer, if only to go over the first draft and reshape it. It does not follow that the workmen or foremen and managers shown in the film must be actual men employed by the foundry. In many instances it will be preferable that they should not, where acting or speaking has to be done. Workers not used to this are apt to be self-conscious and stiff, and as the dialogue has to be carefully memorised if it is to synchronise properly with the actions it accompanies, there is always the danger of a lapse of memory, with the resultant wastage of film. The firm entrusted with the making of the film will provide experienced actors to take these important parts. On the other hand, this adds to the cost, and, if possible, is better avoided. The voices of the speakers in the film must be such as reproduce clearly, and only a percentage of the foundry staff will have voices of this quality. Founders may, therefore, if making a talkie film, have to repress their not unnatural desire to appear in person in the film if their voices are not of the proper timbre for the work.

The Cost Question

What does a film cost is a question virtually impossible to answer "off the top." All depends on whether it is a silent or a talking film, whether it is merely photographic, *i.e.*, a reproduction of actual scenes, or whether a good deal of "studio" work is involved, as may be the case if history is invoked; what the footage of the finished film is; whether or not it is desired to include in the cost the price of projectors to show the film when done. In brief, one may say that from £200 to £1,000 is a reasonable margin of variation. There is, of course, no upper limit, and according to the writer's experience, there seems to be no standard of cost. One firm will quote £500 for a film that another quotes £2,000 for, both being of equal length. All depends on the amount of finish, the detail and the general effect desired, and firms quote according to the particular standard they themselves adopt. For example, in showing a director's office, it may be found when the film is run off that the flex of his bell or telephone is ragged. One firm priding itself on its high standard will retake that shot so that the cord shall be clean and whole; another will not bother. Hence the discrepancies in cost.

Exhibition Work

One important use of films that has not previously been mentioned is at exhibitions. If the exhibition stand is large enough, one can have a small cinema theatre incorporated in it, in which the film is shown. There are appliances that run a film automatically, so that once it has been set in motion, no operation is required. Obviously, this is an excellent means of utilising the film, for a large number of people can be entertained in this way.

The actual preparation of the scenario is really work for a trained writer in collaboration with the foundry staff. If a trained writer is actually employed by the foundry, he will have a new and interesting outlet for his activities, but, even so, he will do well to be guided by the consultant before he goes to any great trouble. There are certain pitfalls for the inexperienced that can be avoided by taking advice. The better plan is to write the dialogue first, and then go over this, indicating where suitable "shots" could be employed, and their character. The consultant will supply technical details, such as the number of words of dialogue for a given footage of film, and it will be advisable to show him those particular scenes or incidents in the foundry that it is desired to film. He will be able to indicate roughly how much footage they will require, which will largely govern the amount of dialogue to cover them.

Having assumed that a film is completed, the next step is to ensure that it is used to the full. Exhibitions are one outlet, and others have been indicated. But in the main, the founder must make his own outlets. He must write to likely people offering his film for display, and not wait for them to come to him. Only by seeing that his expensive selling film works every possible hour it can, will he get back the money he has spent on it; but if he does this energetically, he will find he is well rewarded.

Can the Metallurgist Run a Foundry?

(*Concluded from page* 381.)

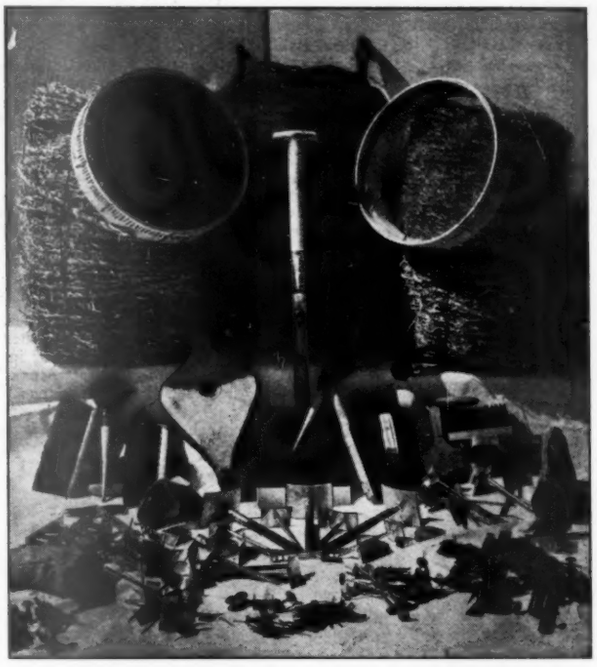
to indecision. Let a man know what he would be at, and there is an end to dithering or delay. It is also suggested that mere knowledge may be dangerous or reckless of the common good unless it is allied with strong character.

In conclusion, the author commends to his readers the words of a famous Scottish divine:

"If you want knowledge, you may get it from books,
"If you lack grace, you may pray for it,
"But if you lack judgment, God help you."

Catalogue Received

Foundry Sand Testing. The Harry W. Dietert Company, of 9,330, Roselawn Avenue, Detroit, Michigan, have sent us a neat 100-page catalogue taking the form of a loose-leaf file. The particular value of this book is that it treats of sand-testing apparatus standardised by the American Foundrymen's Association. Moreover, the technical data included make it a veritable text-book on the subject. If anybody doubt the value of sand testing, a reference to the casting defect chart at the end of the book will immediately have all incredulities dispersed, as herein the relationships of sand to defective production are clearly set out. The lay-out of the catalogue is praiseworthy. First, the machines available are described, then operating instructions are given, and finally a mass of technical data is presented. This publication is available to our readers on request.



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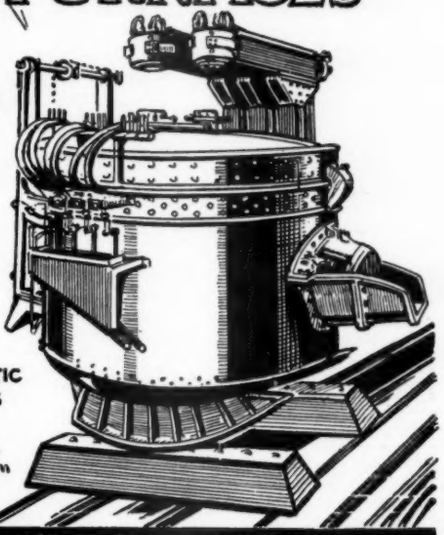

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The Week's News in Brief

Trade Talk

THE OFFICES of Windsor-Richards, Son & Company, Limited, newly registered to carry on business as iron and steel merchants, are at Aldwych House, London, W.C.2.

AT A MEETING of the Brightside Foundry & Engineering Company, Limited, last week, approval was given to the proposal to sub-divide the ordinary £1 shares into 5s. shares.

THE BURMEISTER AND WAIN [DIESEL SYSTEM] OIL ENGINE COMPANY, LIMITED, is being wound up voluntarily. Mr J. S. Baillie, 9, Whitehall, London, S.W.1, is the liquidator.

THE MEDAL of the American Section of the Society of Chemical Industry was awarded last Friday to Prof. E. J. Crane, of Ohio State University, in recognition of his work in abstracts of technical and scientific Papers in all fields of the chemical industry.

THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED, has declared a dividend of 50 cents on the no-par common shares for the fourth quarter, plus an extra payment of 25 cents. This distribution of 75 cents compares with only 40 cents at this time last year.

THE COMBUSTION APPLIANCE MAKERS' ASSOCIATION has appointed a research committee, under the chairmanship of Mr. John Charrington, Junr., to co-ordinate and extend the research that is already being carried out with the object of improving the domestic fire.

THE WORKS MANAGER, departmental managers and foundry foremen of Hale & Hale (Tipton), Limited, entertained Councillor W. E. Hale, J.P., T.C., and his brother, Mr. Thomas L. Hale, at a dinner last week at the George Hotel, Walsall. Mr. L. Brain, works manager, presided over the gathering.

SEVERAL THOUSAND TONS of scrap iron are lying at Dublin wharves awaiting shipment. The export of scrap iron from the Irish Free State capital for the first nine months of the year was 33,187 tons, valued at £111,374, or approximately £3 7s. per ton. For the same period in 1936 the figures were 24,818 tons, valued at £61,468, or £2 9s. per ton.

THE "A" BLAST FURNACE at the new Ebbw Vale steelworks of Richard Thomas & Company, Limited, was blown-in recently. The "A" furnace is one of two which compose the blast-furnace plant under the reconstruction scheme. Both were built by the old Ebbw Vale Company in 1917, but they have been entirely remodelled and brought up to date. The second furnace will come into commission next year.

THE LONDON SECTION of the Institute of Metals is to hold a supper-dance on Wednesday, November 24, at Thames House Restaurant, Millbank, London, S.W.1. Dancing will begin at 7.30 p.m., and the function will conclude at midnight. Tickets, at 6s. 6d. each, are now obtainable from the honorary secretary, Mr. S. V. Williams, Research Laboratories, General Electric Company, Limited, Wembley.

THE 17TH ANNUAL DINNER of the London Iron and Steel Exchange was held in London last week, with Mr. C. Bruce Gardner in the chair. The speakers were the Rt. Hon. the Earl De La Warr (Lord Privy Seal); Lord Hyndley; Mr. Cyril Watts; Mr. Spencer Summers, and Sir Christopher Needham. Guests at the high table included the Earl of Dudley (President of the B.C.I.R.A.); Lord May; Sir Andrew Duncan; Sir Percy Ashby; Sir Gerald E. Chadwych-Healey, Bt.; Sir William Firth; Mr. L. Browett, C.B., C.B.E.; Mr. A. McColl; Mr. L. D. Whitehead; Mr. H. A. Brassert, and Mr. P. G. Donald; Lord Portal; Sir William Brown, K.C.M.G.; Sir William Larke; Sir Nigel Campbell; Mr. Norman L. Hird; Mr. A. C. Macdiarmid; Mr. S. R. Beal; Mr. J. F. L. Elliot; Mr. W. Palmer; Mr. A. W. McQuistan; Mr. Harold Jeans (Chairman, FOUNDRY TRADE JOURNAL), and Mr. F. Baxter. Amongst others present, prominent in the foundry industry, were Mr. C. W. Bigg, the President of the Institute of British Foundrymen; Mr. V. C. Faulkner, a past-President of that Institute and Editor of the FOUNDRY TRADE JOURNAL; Mr. V. Delport; Mr. A. A. Fellows; Mr. S. C. E. Lloyd; Mr. H. W. Lockwood; Mr. H. Power, and Mr. Ben Walmsley, C.B.E. The speeches hinted at the renaissance of the London Iron and Steel Exchange under a new name and with the specific object of unifying the interests of the merchant community.

Personal

MR. JAMES TENNENT, managing director of R. B. Tennent, Limited, Whifflet Foundry, Coatbridge, has been elected Provost of the Burgh.

MR. ROBERT STEWART JOHNSON, managing director at Birkenhead of Cammell, Laird & Company, Limited, has been elected a director of the English Steel Corporation, Limited.

MR. H. SHANKLAND, of the Dunlop Rubber Company, Limited, has been appointed chairman of the Publicity Committee of the Engineering and Hardware Section of the British Industries Fair at Birmingham.

MR. FRANK BLACKWELL, Past-President of the London Branch of the Institute of British Foundrymen, has resigned his position as works manager of the Davis Gas Stove Company, Limited, of Luton. He intends taking a few weeks' holiday, as his health has been far from satisfactory in recent times, and he will then be guided by medical opinion as to the advisability of re-entering industry.

DR. L. B. HUNT, M.Sc., A.M.I.A.E., for the past two and a half years Editor of "The Metal Industry," has resigned to take up an appointment as technical manager of Mallory Metallurgical Products, Limited. This company has recently erected a plant at Croydon, and will produce and market in this country and in Europe the range of hard high-conductivity alloys developed by P. R. Mallory & Company, Inc., Indianapolis.

MR. GEORGE A. POPE, deputy managing director of W. Canning & Company, Limited, electro-platers' engineers, of Birmingham, has been appointed joint managing director with Mr. Ernest R. Canning, the present managing director. Mr. Frank H. Ewens, secretary, has been elected a director. Mr. Pope has been connected with the business for forty years and has been a director since the formation of the company in 1920. Mr. Ewens has been associated with the business for thirty years and has been secretary since 1924.

Wills

KIMPTON, A. C., late delegate director of Imperial Chemical Industries, Limited	£26,304
OXLEY, G. H., of Sheffield, ironfounder, managing director of George Oxley & Sons, Limited	£111,300
MEADOWS, HENRY, of Wolverhampton, founder and chairman of Henry Meadows, Limited, petrol engine and gear-box manufacturers	£56,298

Obituary

THE DEATH has occurred of Mr. J. N. Adam, managing director of Gray & Caldwell, Limited, brassfounders, of Paisley.

MR. DANIEL W. SUTTIE, who served his apprenticeship with Alexander Shanks & Son, Limited, ironfounders and engineers, Arbroath, before going to South Africa in 1911, has died in Durban.

Contracts Open

Glasgow, December 4.—40 cast-iron mouthpieces for vertical retorts, for the Gas Department. The General Manager, Gas Department, 30, John Street, Glasgow.

Llandudno, November 20.—Supply and erection of pumping machinery, consisting of multi-stage centrifugal-type pumps and electrical equipment, for the Urban District Council. The Engineer, Town Hall, Llandudno.

Plymouth, November 15.—6,000 yds. of 3-in., 4-in., 6-in., 9-in. and 12-in. British standard spun cast-iron pipes, cement and concrete lined, for the Town Council. The Water Engineer, Stonehouse Town Hall, Plymouth.

Carew, November 17.—Supply, laying and jointing of 13¾ miles of 4-in., 3-in. and 2-in. spun cast-iron pipes, etc., for the Pembroke Rural District Council. J. O. Parry & Lewis, consulting engineers, Ammanford. (Fee £3 3s., returnable.)

Company Meeting

Lightalloys, Limited

The annual meeting of Lightalloys, Limited, was held in London, on November 2. CAPT. OLIVER LYTTELTON (chairman), who presided, said that they had a very large order-book, which appeared likely to keep the present extended plant fully occupied for about 18 months. The company was responsible for the introduction into this country of modified aluminium silicon alloy. This alloy, "Alpax," was now very widely used. As a result of considerable experimental work, it had been found that, by adding certain elements to this alloy and then subjecting it to heat-treatment, certain of its physical properties were greatly improved. This material was now being largely used for highly stressed parts for aircraft and general engineering purposes. They continued to produce "Alpax" and all other aluminium alloy sand and die castings, ranging in weight from one ton each for the heaviest "Alpax" sand casting down to a fraction of an ounce for the lightest die casting. These castings were supplied to practically every branch of industry in this country.

Company Reports

Johnson & Phillips, Limited.—Interim dividend of 5 per cent.

Glenfield & Kennedy, Limited.—Interim ordinary dividend of 5 per cent.

British Oxygen Company, Limited.—Interim dividend on the ordinary stock of 7 per cent., or 1s. 4.8d. per £1 unit, on account of the year 1937.

Lightalloys, Limited. — Profit, after depreciation, for the year ended June 27, £37,015; brought in, £6,139; to income tax and N.D.C. reserve, £3,700; special depreciation reserve, £5,000; staff-pension scheme reserve, £2,500; final dividend of 1s. 1½d. per 5s. share, making 35 per cent. for the year; carried forward, £6,079.

Samuel Osborn & Company, Limited.—Profit for year ended July 31, after provision for pensions and contingencies, depreciation, bad and doubtful debts, and tax, £60,153; brought in, £36,455; preference dividends, £7,183; interim dividend of 2½ per cent. on the ordinary shares, £5,494; final dividend of 12½ per cent., £27,592; to a dividend reserve account, £15,000; carried forward, £41,339.

Forthcoming Events

NOVEMBER 16.

Institute of Welding (North-Eastern Branch):—"Casting, Welding and General Fabrication," Paper by Gordon Pearson, at Armstrong College, Newcastle-upon-Tyne, at 7.30 p.m.

NOVEMBER 17.

Manchester Metallurgical Society:—"Modern Views of Cast Iron," Paper by Dr. A. L. Norbury, at Constitutional Club, St. Ann's Street, Manchester, at 7 p.m.

Institute of British Foundrymen

NOVEMBER 15.

Bristol Section:—"Coreshop Practice," Paper by N. Newman, at Merchant Venturers' Technical College, Bristol, at 7 p.m.

NOVEMBER 18.

East Anglian Section:—"Impressions of Modern Ironfoundry Practice in the U.S.A.," Paper by Dr. A. B. Everest, at North-East Essex Technical College and School of Art, Colchester, at 7.30 p.m.

NOVEMBER 19.

Middlesbrough Branch:—Visit to Darlington Forge, Limited, Darlington.

NOVEMBER 20.

East Midlands Branch:—"Examples of Practical Moulding," Paper by F. G. Butters, at the Technical College, Derby, at 6 p.m.

Falkirk Section:—"Cement Moulds," Paper by A. Haines, at Temperance Café, Lint Riggs, Falkirk, at 6 p.m.

Wales and Monmouth Branch:—Cinematograph lecture, by S. E. Dawson, at Y.M.C.A., Llanelly, at 6.30 p.m.

The Institute of Vitreous Enamellers

NOVEMBER 18.

Southern Section:—"Analyses of Cast Iron suitable for Vitreous Enamelling," Paper by H. Cowan, B.Sc., at Charing Cross Hotel, London, W.C.2, at 8 p.m.

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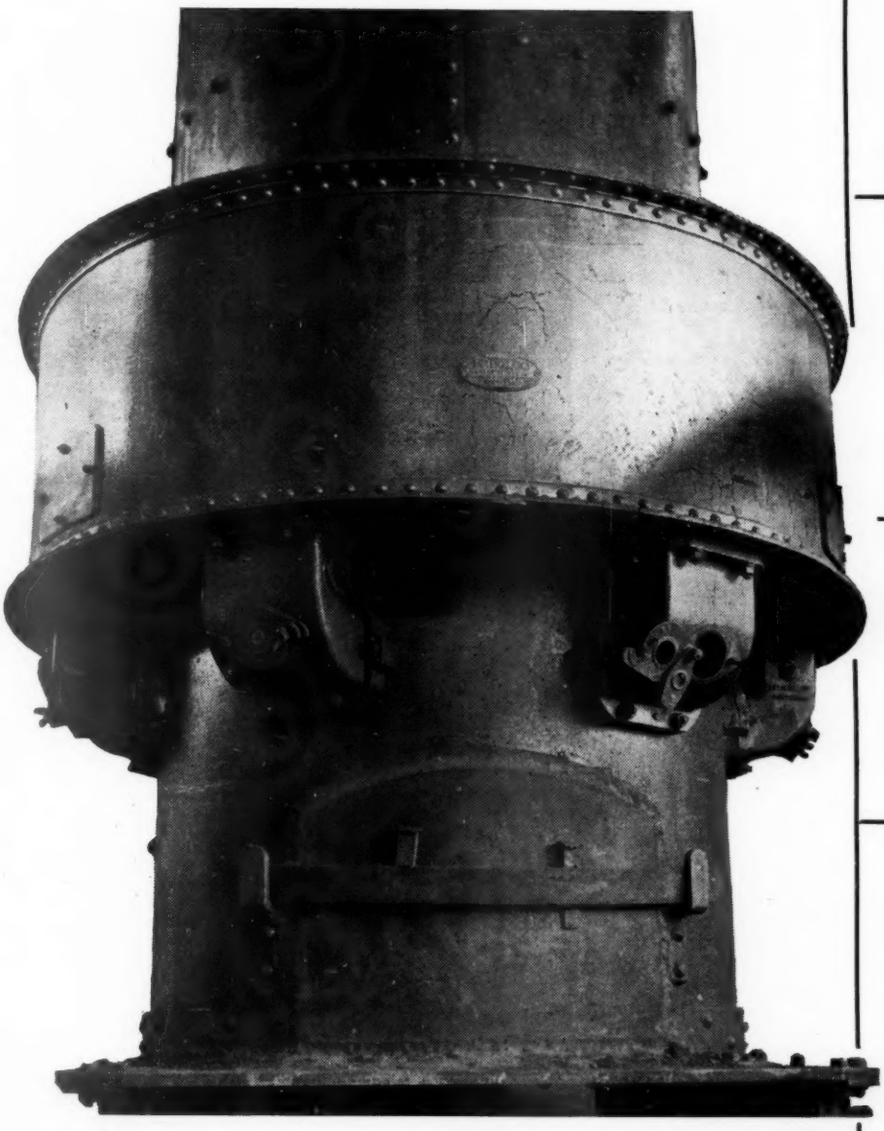

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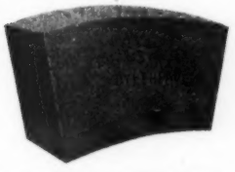
Manufactured from the famous Glenboig Fireclay, this firebrick has enjoyed a world wide reputation for almost a century

2—WHITE CARR

Low porosity is essential in the case of furnace linings subjected to abrasive forces and to slag action, and in this respect White Carr Firebricks have proved to be particularly valuable

3—DYKEHEAD



Since 1916 Dykehead bricks have been enjoying an ever increasing reputation for uniformity of fine quality

4—STOUR

Stour firebricks are capable of withstanding very high temperatures without melting or splitting and where sudden changes of temperature have to be contended with, are unsurpassed

Please address enquiries to the nearest Sales Office:

GENERAL REFRACTORIES LTD.

Telephone: *Sheffield* 31113 (6 *lines*) **GENEFAX HOUSE, SHEFFIELD, 10** *Telegrams:* *"Genefax Sheffield"*

LONDON OFFICE: Russell House, Adelphi, W.C.2. Telephone: Temple Bar 3511. Telegrams: "Genefax, Rand-London." (Mr. A. C. Turner).

SCOTTISH OFFICE: 48, West Regent Street, Glasgow, C.2. Telephone: Douglas 6108 (3 lines). Telegrams: "Genefax, Glasgow." (Mr. C. A. G. Thomson).

SWANSEA OFFICE: Metropole Chambers, Wind Street. Telephone: 3680. Telegrams: "Genefax, Swansea." (Mr. D. F. Hood-Williams).

MANCHESTER OFFICE: 9, Albert Square. Telephone: Blackfriars 6130 Telegrams: "Genefax, Manchester." (Mr. S. G. Throssell).

MIDDLESBROUGH OFFICE: Halifax Bldgs., Exchange Place, Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough." (Mr. J. A. Williams).

CARDIFF OFFICE: 17, Windsor Place, Telephone: 5796. Telegrams: "Genefax, Cardiff." (Mr. F. E. Rutter).

Raw Material Markets

In conformity with a recommendation of the British Iron and Steel Federation and with the concurrence of the Import Duties Advisory Committee, nine steel associations, covering the main basic steel products of this country, have decided to maintain their prices at the present level until the end of 1938, subject to the proviso in all sales and contracts that deliveries after December 31, 1938, will be at association prices then ruling.

In spite of recent world disturbances, it is explained, there is no abatement of the demand for steel products in this country, and in taking this course in the face of increased costs of its raw materials the iron and steel industry is actuated by the desire to contribute to the prolongation of the present level of trade activity and by the hope that some mitigation of the burden of its own material costs may be secured by co-operation with the interests involved.

The associations concerned are the Scottish Steel Makers' Association, the Midland and Welsh Steel Makers' Association, the North-East Coast Steel Makers' Association, the British Joist Makers' Association, the Soft Basic Billet Association, the Basic Special Steel Billet Association, the Free Cutting Steel Billet Association, the Forging, Drop Forging and Stamping Billet Association, and the Sheet Bar Association.

That iron and steel consumers do not favour the system of booking orders for payment at the prices ruling at the date of despatch has been indicated by the recent absence of new business. Prices of steel products for trade after the turn of the year are now known, and there should be more business moving during the remaining months of 1937. Many producers will have fairly heavy commitments still to be met after December 31. Pig-iron consumers still await an announcement of the price levels which are to rule next year. Basic iron is to remain at its present levels until June 30, 1938, but new business in hematite and ordinary foundry irons is still subject to a price clause.

Pig-Iron

MIDDLESBROUGH.—Quiet conditions continue to prevail in this area so far as new business is concerned. Makers' chief anxiety at the present time is to expedite deliveries in order to reduce to a minimum arrears at the end of the year. The question of prices for 1938 has still to be settled and unofficial estimates vary, but it is likely that the increase in foundry iron prices will be less than the highest of these. No. 3 Cleveland G.M.B. is now quoted at 106s. per ton, but is subject to a rebate, under the recently-introduced loyalty scheme, of 5s. per ton. Production of hematite is adequate to meet the demand, but consumers are still unable to obtain supplies in excess of their current requirements. The transaction of new business is in abeyance pending a decision with regard to prices for next year's deliveries.

LANCASHIRE.—Foundry and forge irons continue to be well taken up under contracts, and consumers are receiving satisfactory deliveries. For delivery to users in the Lancashire zone, Derbyshire and Staffordshire No. 3 foundry irons are quoted on the basis of 114s., with Northants at 112s. 6d. and Derbyshire forge iron at 109s. to 111s., according to the class of consumer. The foregoing prices are subject to a rebate of 5s. per ton. Scottish pig-iron remains very scarce in this area at 140s. Hematite prices are unchanged at 130s. 6d. for East Coast and 131s. for West Coast, delivered equal to Manchester and subject to a rebate of 5s.

MIDLANDS.—While the price uncertainty persists, makers will not enter into business involving deliveries after December 31, except on the condition that consumers pay the price operating at the date of despatch. Supplies are definitely easier, and users are receiving quite substantial deliveries. For delivery to Birmingham and Black Country stations, Northamptonshire No. 3 is quoted at 108s. 6d., with Derbyshire, Lincolnshire and North Staffordshire No. 3 at 111s. per ton. An extra of 7d. per ton is invoiced if delivery into works is required, while a rebate of 5s. is obtainable under the loyalty scheme. There is little improvement to report among light-castings founders, but the opportunity is thus afforded to despatch increased tonnages to other consumers. Machine-tool makers have increasing requirements of special irons, while the demand for these grades is also expanding in other directions. Generally, ordinary grades of hematite are fairly plentiful, but special descriptions are not so easily obtained. For delivery to Birmingham and district, East Coast No. 3 is quoted at £6 13s. 6d. and West Coast mixed numbers at £6 14s. 6d. An additional 1s. 6d. per ton is charged for deliveries into works.

SCOTLAND.—The price of No. 3 Scottish foundry iron f.o.t. furnaces remains at 118s., with No. 1 at 120s. 6d. The loyalty rebate of 5s. per ton which has been introduced elsewhere is not applicable to this district. Most consumers are able easily to obtain good deliveries, and in some cases stocks are being accumulated. There are still no supplies of Cleveland iron available in this area, but some Continental foundry iron is being imported. Hematite mixed numbers are quoted at 123s., with Scottish basic at 107s. 6d. and Indian and English basic at 100s., all less 5s. per ton rebate and delivered steelworks. Local steelworks remain very active.

Coke

Quotations are firm on the foundry-coke market. Generally, business is confined to deliveries over the winter months, although makers are willing to negotiate over the whole of 1938. For delivery to Birmingham and district, best Durham coke is quoted at 55s. 9d., with Welsh coke at from 55s. to 65s. per ton, according to quality.

Steel

The stabilisation of home trade prices for steel announced this week until the end of 1938 has been well received in all departments of the market and has cleared the way for the transaction of new business, says the official report of the London Iron and Steel Exchange. A considerable tonnage of orders had been held up in view of the uncertainty of the position which would rule next year, and with the settlement of this question, a heavy volume of inquiry was released. The position of the steelworks, however, has not been altered and with enough work on their books to keep them employed for months to come they are not anxious to accept further far forward commitments. In the majority of cases they will enter 1938 with a considerable tonnage of arrears of orders to work off. In the semi-finished steel department stringent conditions continue to rule, and in spite of the increased production and additional imports, there is still a gap between supply and demand. The request for finished steel is unrelaxed and it will probably be necessary to continue the system of rationing for some time, notwithstanding the record output.

Scrap

Iron and steel scrap merchants throughout the country have only small tonnages to offer, as contract specifications account for almost all available supplies. The position appears to be a little easier in Scotland, but consumers in other areas are having to negotiate for foreign material or to take up supplies from various parts of the country, thus adding, of course, to the cost.

Metals

Copper.—Fresh weakness has occurred in this market during the past week, and the price on Friday fell below the £40 mark for the first time since October, 1936. This relapse apparently was the cause of rumours to the effect that a further tightening-up of the recently-reimposed restriction was likely. Under the scheme the principal copper-producing countries outside the United States will curtail production to 105 per cent. of standard tonnages as from the end of the month. Buying has been very quiet recently. In the United States price movements still occur. The American Smelting & Refining Company cut the price of domestic copper to 11 cents per lb., on Friday, which followed a reduction to 11¼ cents the previous day.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £40 7s. 6d. to £40 8s. 9d.; Friday, £39 5s. to £39 7s. 6d.; Monday, £36 3s. 9d. to £36 6s. 3d.; Tuesday, £39 8s. 9d. to £39 10s.; Wednesday, £39 2s. 6d. to £39 5s.

Three Months.—Thursday, £40 13s. 9d. to £40 15s.; Friday, £39 12s. 6d. to £39 15s.; Monday, £36 11s. 3d. to £36 12s. 6d.; Tuesday, £39 16s. 3d. to £39 17s. 6d.; Wednesday, £39 8s. 9d. to £39 10s.

Tin.—The price of this metal also recently reached the lowest level for more than twelve months, and the tone of the market remains very quiet.

Criticism of the treatment of Malaya under the tin restriction scheme was made by Mr. D. J. Ward, chairman of the Pahang Consolidated Company, Limited, speaking at the annual meeting recently. He said that under this restriction agreement they had the spectacle of most countries striving their utmost—and failing—to obtain their permissible export allowance; whereas Malaya had 22 dredges lying idle; some of these dredges were, however, obsolete. The position would probably right itself in time as regards some, but not all, countries, but at the moment Malaya was unfairly treated. The unfortunate omission in arriving at the basic figure for the standard tonnage of 1929 as set forth in the first restriction agreement was not corrected in the second agreement and individual mines in Malaya were still only allowed to produce about 73 per cent. of the international allowance, so that Malaya was now on a quota of 80 per cent., which would be reduced to about 62 per cent. if the 25 per cent. cut came into force.

Official quotations were as follow :—

Cash.—Thursday, £198 to £198 5s.; Friday, £192 10s. to £193 10s.; Monday, £181 5s. to £181 10s.; Tuesday, £188 10s. to £189; Wednesday, £192 5s. to £192 15s.

Three Months.—Thursday, £197 15s. to £198; Friday, £192 to £193; Monday, £180 5s. to £180 10s.; Tuesday, £187 5s. to £187 10s.; Wednesday, £191 10s. to £192.

Spelter.—There is little change to report in this market, which continues to be under the influence of the prevailing uncertainty. Business has involved only small tonnages. Quiet conditions continue on the United States market.

In his speech at the annual meeting of the Imperial Smelting Corporation, Limited, Viscount Horne said that the results from zinc smelting were again unsatisfactory. They were Customs smelters, i.e., they bought, in open competition with foreign smelters, their raw materials in the form of zinc concentrates from mines in the United Kingdom, Newfoundland, Australia and other places, paying for the zinc content according to the ruling price of zinc and receiving a charge for conversion into metal—known as a returning charge—out of which they had to pay for all wages, fuel and other supplies, transport, distribution, &c. In the result they hoped to have a surplus which would give them some reward on the capital employed. These were the reasons why the price of zinc was to them of less importance than the cost incurred by them in producing it. When it was remembered that it took 4½ to 5 tons of coal and 4½ to 5 man days to produce a ton of zinc by the methods which it was necessary to employ in this country, they would recognise how high was the percentage of labour-cost involved in converting zinc in concentrates into marketable metal. It was because of the greater cost of fuel, higher wages, dearer transport and more burdensome taxation in this country that their industry required some safeguard from external competition. The galvanising, brass, zinc sheet and other industries—all large users of zinc—were sheltered from external competition by import duties alone, or import duties plus quota restrictions. They had no objection whatever to the protection which they believed these industries justifiably received, but they took exception to the fabricator of zinc receiving suitable safeguards and the producer of it practically none.

Daily market prices :—

Ordinary.—Thursday, £16 2s. 6d.; Friday, £15 7s. 6d.; Monday, £14 15s.; Tuesday, £15 10s.; Wednesday, £15 17s. 6d.

Lead.—Demand has been on a fairly good scale, but consumers are reluctant to purchase too far ahead at the present time, most business being for prompt deliveries. Although supplies are adequate, they are not too plentiful, but prices have continued their downward trend. The price in the United States has declined to 5.25 cents per lb.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £16 17s. 6d.; Friday, £16 5s.; Monday, £15 11s. 3d.; Tuesday, £16 1s. 3d.; Wednesday, £17.

Scrap.—It is certain that stocks at the consumers' end are small, but, nevertheless, current buying also is small. This, of course, is due to the existing uncertainty and little change in the position can be expected until stability is achieved.

Approximate selling prices for old metal:—New aluminium cuttings, £82; rolled, £67; cast, £40; foil, £94 to £98. Copper, £37 to £41; braziery, £35. Brass (clean), £26 to £28. Zinc, £10. Lead, £16. Gunmetal, £38 to £39.

BA/42

THE LOW EXPANSION PISTON ALLOY

—low co-efficient of expansion, lightness, rigidity and high tensile strength at elevated temperatures.

THE **British Aluminium** CO. LTD

HEAD OFFICE: ADELAIDE HOUSE, LONDON, E.C.4

Telephone: Mansion House 5561 (6 lines).
Telegrams: "Crycolite, Bilgate, London."

F.T.J. 11/11/37

RAW MATERIALS—PRICE LIST

(Wednesday, November 10, 1937)

COPPER

	£	s.	d.
Standard cash	39	2	6
Three months	39	8	9
Electrolytic	43	10	0
Tough	43	15	0
Best selected	44	5	0
Sheets	73	0	0
India	54	15	0
Wire bars	45	10	0
Ingot bars	45	10	0
H.C. Wire rods	49	0	0
Off. av. cash, Oct.	45	8	9
Do., 3 mths., Oct.	45	12	11
Do., Sttlmnt., Oct.	45	8	9½
Do., Electro, Oct.	51	9	9½
Do., B.S., Oct.	51	17	6
Do., Wire bars, Oct.	52	7	1½
Solid drawn tubes			12½d.
Brazed tubes			12½d.
Wire			8½d.

BRASS

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	9½d.
Rods, extd. or rlld.	6½d.
Sheets to 10 w.g.	8½d.
Wire	8½d.
Rolled metal	8½d.
Yellow metal rods	6¾d.

TIN

	£	s.	d.
Standard cash	192	5	0
Three months	191	10	0
English	192	5	0
Bars	194	5	0
Straits	195	15	0
Eastern	178	10	0
Banca (nom.)		—	
Off. av. cash, Oct.	224	0	11¾
Do., 3 mths., Oct.	223	9	10¾
Do., Sttlmt., Oct.	224	1	10¾

SPELTER

	£	s.	d.
Ordinary	15	17	6
Remelted	13	10	0
Hard	13	0	0
Electro, 99.9	19	10	0
English	16	15	0
India	15	10	0
Zinc dust	23	0	0
Zinc ashes	5	15	0
Off. aver., Oct.	17	16	9½
Aver., spot, Oct.	17	14	5 3/14

LEAD

	£	s.	d.
Soft foreign, ppt.	17	0	0
Empire (nom.)	16	18	9
English	19	0	0
Off. aver., Oct.	18	5	9¾
Aver. spot, Oct.	18	5	2¼

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	28 10 0 to 29	0	0
Do., V.M. ex-whse.	28 10 0 to 29	0	0
Rods	24	5	0

ANTIMONY

	£	s.	d.
English	92 10 0 to 93	10	0
Chinese, ex-whse. (nom.)	76	0	0
Crude, c.i.f.	47	0	0

QUICKSILVER

	£	s.	d.
Quicksilver	13	0	3

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	14 10 0
45/50%	12 0 0
75%	17 0 0
Ferro-vanadium	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/9 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	9/3 lb.
Tungsten metal powder—	
98/99%	9/6 lb.
Ferro-chrome—	
2/4% car.	34 15 0
4/6% car.	24 5 0
6/8% car.	24 0 0
8/10% car.	24 0 0
Ferro-chrome—	
Max. 2% car.	36 0 0
Max. 1% car.	38 5 0
Max. 0.5% car.	41 0 0
70% carbon-free	10d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	8/6 to 8/9 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£18 15 0 to 19 5 0
76/80% packed	£19 15 0 to 20 5 0
76/80% export	£22 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 10d.
Finished bars, 18% tungsten	5s. 0d.

Per lb. d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales (West)—						
Heavy steel, best	3	8	6 to	3	11	0
Mixed iron and steel	3	6	0 to	3	8	6
Heavy cast iron	3	8	6 to	3	11	0
Good machinery				3	17	6
Cleveland—						
Heavy steel, best	3	7	0 to	3	9	6
Steel turnings				2	15	0
Heavy cast iron				4	5	0
Heavy machinery				4	10	0
Midlands—						
Short heavy steel				4	0	0
Light cast-iron scrap				3	2	6
Heavy wrought iron	4	0	0 to	4	5	0
Steel turnings	2	5	6 to	2	8	0
Scotland—						
Heavy steel, best	3	5	0 to	3	7	6
Ordinary cast iron	4	7	6 to	4	10	0
Cast-iron borings	2	0	0 to	2	2	6
Wrot-iron piling				4	17	6
Heavy machinery	4	15	0 to	4	17	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	31	0	0
Brass	21	10	0
Lead (less usual draft)	13	10	0
Tea lead	10	10	0
Zinc	8	10	0
New aluminium cuttings	71	0	0
Braziery copper	27	0	0
Gunmetal	31	0	0
Hollow pewter	125	0	0
Shaped black pewter	90	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	108/6*
,, No. 3	106/-*
,, No. 4	105/-*
Forge No. 4	105/-*
Hematite No. 1	123/-*
Hematite M/Nos.	122/6*
N.W. Coast—	
Hem. M/Nos. d/d Glas.	123/-*
,, d/d Birm.	134/6*
Malleable iron d/d Birm.	160/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	108/-*
,, No. 3 fdry.	111/-*
Northants forge	105/6*
,, fdry. No. 3	108/6*
,, fdry. No. 1	111/6*
Derbyshire forge	108/-*
,, fdry. No. 3	111/-*
,, fdry. No. 1	114/-*
Scotland—	
Foundry, No. 1, f.o.t.	120/6
,, No. 3, f.o.t.	118/-
Cleveland No. 3, Glasgow	112/-*
,, ,, Falkirk	109/-*
Scottish hem. M/Nos. d/d	123/-*
Sheffield (d/d district)—	
Derby forge	105/6*
,, fdry. No. 3	108/6*
Lincs forge	105/6*
,, fdry. No. 3	108/6*
W.C. hematite	128/6*
Lancashire (d/d eq. Man.)—	
Derby fdry, No. 3	114/-*
Staffs fdry. No. 3	114/-*
Northants fdry. No. 3	112/6*
Cleveland fdry. No. 3	114/-*
Glengarnock, No. 3	140/-
Clyde, No. 3	140/-
Monkland, No. 3	140/-
Summerlee, No. 3	140/-
Eglinton, No. 3	140/-
Gartsherrie, No. 3	140/-
Shotts, No. 3	140/-

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	13	5	0 to	13	15	0
Nut and bolt iron	11	12	6 to	12	2	6
Hoops				14	2	6
Marked bars (Staffs) f.o.t.				15	15	0
Gas strip				14	2	6
Bolts and nuts, ¾ in. × 4 in.				17	10	0 and up.
Steel—						
Plates, ship, etc.	11	8	0 to	11	10	6
Boiler plts.	11	18	0 to	12	0	6
Chequer plts.				13	0	6
Angles				11	0	6
Tees				12	0	6
Joists				11	0	6
Rounds and squares, 3 in. to 5½ in.				12	0	6
Rounds under 3 in. to ¾ in. (Untested)				11	9	0
Flats—8 in. wide and over				11	5	6
,, under 8 in. and over 5 in.				11	10	6
Rails, heavy				10	2	6
Fishplates				14	2	6
Hoops (Staffs)				12	4	0
Black sheets, 24g. (4-t. lots)				15	15	0
Galv. cor. shts. (,,)				19	10	0
Galv. flat shts. (,,)				20	0	0
Galv. fencing wire, 8g. plain				20	5	0
Billets, soft, 100-ton lots				7	17	6
Sheet bars				7	15	0
Tin bars				7	15	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	11d.
Sheet to 10 w.g.	11½d.
Wire	12⅝d.
Rods	13½d.
Tubes	18½d.
Castings	15½d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop. £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8½
To 15 in. wide	1/2⅝ to 1/8⅝
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
to 10g.	1/5½ to 2/0½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/4½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb. box	$5.35

COKE (at ovens)

Welsh foundry	42/6
,, furnace	37/6
Durham foundry	38/6
,, furnace	37/6
Scottish foundry	42/6
,, furnace	40/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	23/9 to 24/6
,,	28×20 ,,	47/6 to 49/-
,,	20×10 ,,	36/- to 36/6
,,	18¾×14 ,,	25/9 to 26/3
C.W.	20×14 ,,	21/- to 22/-
,,	28×20 ,,	42/- to 44/-
,,	20×10 ,,	31/6 to 32/-
,,	18¾×14 ,,	22/6 to 23/-

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£12	0	0 to	£13	0	0
Bars-hammered, basis	£20	0	0 to	£22	0	0
Bars and nail-rods, rolled, basis	£19	0	0 to	£20	0	0
Blooms	£18	0	0 to	£19	0	0
Keg steel	£30	0	0 to	£35	0	0
Faggot steel	£20	0	0 to	£25	0	0
Bars and rods dead soft st'l	£19	0	0 to	£20	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.		
Nov.	4 ..	40	7	6	dec.	17/6
,,	5 ..	39	5	0	,,	22/6
,,	8 ..	36	3	9	,,	61/3
,,	9 ..	39	8	9	inc.	65/-
,,	10 ..	39	2	6	dec.	6/3

Electrolytic Copper

		£	s.	d.		
Nov.	4 ..	45	10	0	dec.	10/-
,,	5 ..	44	0	0	,,	30/-
,,	8 ..	42	0	0	,,	40/-
,,	9 ..	43	10	0	inc.	30/-
,,	10 ..	43	10	0	No	change

Standard Tin (cash)

		£	s.	d.		
Nov.	4 ..	198	0	0	dec.	30/-
,,	5 ..	192	10	0	,,	110/-
,,	8 ..	181	5	0	,,	225/-
,,	9 ..	188	10	0	inc.	145/-
,,	10 ..	192	5	0	,,	75/-

Tin (English ingots)

		£	s.	d.		
Nov.	4 ..	198	0	0	dec.	30/-
,,	5 ..	192	10	0	,,	110/-
,,	8 ..	181	5	0	,,	225/-
,,	9 ..	188	10	0	inc.	145/-
,,	10 ..	192	5	0	,,	75/-

Spelter (ordinary)

		£	s.	d.		
Nov.	4 ..	16	2	6	dec.	3/9
,,	5 ..	15	7	6	,,	15/-
,,	8 ..	14	15	0	,,	12/6
,,	9 ..	15	10	0	inc.	15/-
,,	10 ..	15	17	6	,,	7/6

Spelter (Electro, 99.9 per cent.)

		£	s.	d.		
Nov.	4 ..	19	15	0	dec.	3/9
,,	5 ..	19	0	0	,,	15/-
,,	8 ..	18	7	6	,,	12/6
,,	9 ..	19	2	6	inc.	15/-
,,	10 ..	19	10	0	,,	7/6

Lead (soft foreign, prompt)

		£	s.	d.		
Nov.	4 ..	16	17	6	dec.	5/-
,,	5 ..	16	5	0	,,	12/6
,,	8 ..	15	11	3	,,	13/9
,,	9 ..	16	1	3	inc.	10/-
,,	10 ..	17	0	0	,,	18/9

Lead (English)

		£	s.	d.		
Nov.	4 ..	19	0	0	dec.	5/-
,,	5 ..	18	5	0	,,	15/-
,,	8 ..	17	15	0	,,	10/-
,,	9 ..	18	5	0	inc.	10/-
,,	10 ..	19	0	0	,,	15/-

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	46 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	42 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	48 11	48 4	48 6	48 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	85 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	99 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	223 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	126 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	83 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 6	67 6	66 10½	65 9	73 2½
1928	65 0	65 0	65 6	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	65 9½
1929	66 0	66 9	67 0	68 1½	69 5	71 10½	72 9	72 6	72 6	72 6	72 6	72 6	70 4½
1930	72 6	72 6	70 0	67 6	67 6	67 6	67 6	64 6	63 6	63 6	63 6	63 6	66 11½
1931	59 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 7
1932	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6
1933*	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6
1934*	62 6	65 0	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	66 10½
1935*	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	69 4½	70 0	67 10½
1936*	70 0	70 0	70 0	70 0	70 0	70 0	75 0	75 0	75 0	75 0	75 0	81 0	73 0
1937*	81 0	81 0	81 0	81 0	81 0	81 0	101 0	101 0	101 0	101 0	—	—	—

* Delivered Middlesbrough area. Prior to 1933, prices were f.o.t. furnaces.

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